**United States Department of Energy**
**Savannah River Site**

# Statement of Basis/Proposed Plan for the M Area Operable Unit (MAOU) (U)

**CERCLIS Number: 92**

**WSRC-RP-2007-4068**

**Revision 1**

**February 2008**

**Prepared by:**
**Washington Savannah River Company LLC**
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**Aiken, SC 29808**

**Prepared for the U.S. Department of Energy under Contract No. DE-AC09-96SR18500**

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Prepared for
U.S. Department of Energy
and
Washington Savannah River Company LLC
Aiken, South Carolina

## CERTIFICATION

Statement of Basis/Proposed Plan for the
M Area Operable Unit (MAOU) (U)

WSRC-RP-2007-4068, Revision 1, February 2008

[REF: 40CFR270.11 (d)(1)]

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

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Savannah River Operations Office

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ARAR | applicable or relevant and appropriate requirement |
| BRA | baseline risk assessment |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CMCOC | contaminant migration constituent of concern |
| CMRCOC | contaminant migration refined constituent of concern |
| CMI | corrective Measures Implementation |
| CMS | Corrective Measures Study |
| cm/s | centimeter per second |
| COC | constituent of concern |
| CSM | conceptual site model |
| D&D | deactivation and decommissioning |
| DUS | dynamic underground stripping |
| EE/CA | engineering evaluation/cost analysis |
| FDE | Facility Decommissioning Evaluation |
| FFA | Federal Facility Agreement |
| FS | Feasibility Study |
| ft | foot |
| $ft^2$ | square foot |
| GCL | geosynthetic clay liner |
| HH | human health |
| HI | Hazard Index |
| IPSL | Inactive process sewer line |
| LETF | Liquid Effluent Treatment Facilities |
| LLC | Limited Liability Company |
| LUC | Land Use Control |
| LUCAP | Land Use Control Assurance Plan |
| LUCIP | Land Use Control Implementation Plan |
| m | meter |
| $m^2$ | square meter |
| $m^3$ | cubic meter |
| MAOU | M Area Operable Unit |
| MCL | maximum contaminant level |
| mg/kg | milligram per kilogram |
| MIPS | M-Area Inactive Process Sewer |
| MIPSL | M-Area Inactive Process Sewer Line |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NPL | National Priorities List |
| O&M | operations and maintenance |
| OU | operable unit |
| ppm | parts per million |
| PAH | polyaromatic hydrocarbon |
| PCB | polychlorinated biphenyls |
| PCE | tetrachloroethylene |
| PRG | preliminary remediation goal |
| PTSM | principal threat source material |

## LIST OF ACRONYMS AND ABBREVIATIONS *(Continued)*

| | |
|---|---|
| RAIP | Remedial Action Implementation Plan |
| RAO | remedial action objective |
| RBC | risk-based concentration |
| RCO | radiological control operations |
| RCOC | refined constituent of concern |
| RCRA | Resource Conservation and Recovery Act |
| RFI | RCRA Facility Investigation |
| RG | remedial goal |
| RGO | remedial goal option |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RSER | Removal Site Evaluation Report |
| SARA | Superfund Amendments Reauthorization Act |
| SB/PP | Statement of Basis/Proposed Plan |
| SCDHEC | South Carolina Department of Health and Environmental Control |
| SCHWMR | South Carolina Hazardous Waste Management Regulations |
| SE | Site Evaluation |
| SRS | Savannah River Site |
| SVE | soil vapor extraction |
| TBC | to be considered |
| TCA | trichloroethane |
| TCE | trichroloethylene |
| TSCA | Toxic Substances Control Act |
| URMA | underground radioactive material area |
| USDOE | United States Department of Energy |
| USEPA | United States Environmental Protection Agency |
| VOC | volatile organic compound |
| WSRC | Washington Savannah River Company |
| $yd^3$ | cubic yard |

# I. INTRODUCTION AND BACKGROUND

## Introduction

This Statement of Basis/Proposed Plan (SB/PP) is being issued by the United States Department of Energy (USDOE), which functions as the lead agency for Savannah River Site (SRS) remedial activities, with concurrence by the United States Environmental Protection Agency (USEPA) and the South Carolina Department of Health and Environmental Control (SCDHEC). The purpose of this SB/PP is to describe the preferred remedial alternative(s) for the M Area Operable Unit (MAOU), and to provide for public involvement in the decision-making process. The MAOU is located at the SRS in Aiken County, South Carolina (see Figure 1).

SRS manages certain waste materials that are regulated under the Resource Conservation and Recovery Act (RCRA), a comprehensive law requiring responsible management of hazardous waste. The MAOU is a solid waste management unit under RCRA Section 3004(u). SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on September 30, 2003 (SC1 890 008 989). Module VIII of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List (NPL). The inclusion created a need to integrate the established RCRA Facility Investigation (RFI) program with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 U.S.C. § 9620, USDOE has negotiated a Federal Facility Agreement (FFA) (FFA 1993) with the USEPA and SCDHEC to coordinate remedial activities at SRS as one comprehensive strategy that fulfills these dual regulatory requirements. The FFA lists the MAOU as a RCRA/CERCLA unit requiring further evaluation using an investigation/assessment process that integrates and combines the RFI process with the CERCLA Remedial Investigation (RI) process to determine the actual or potential impact to human health and the environment of releases of hazardous substances to the environment.

Both RCRA and CERCLA require the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternatives. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA 42 U.S.C. § 9613 and 9617. These requirements include establishment of an Administrative Record File that documents the investigation and selection of remedial alternatives and allows for review and comment by the public regarding those alternatives (See Section II). The Administrative Record File must be established at or near the facility at issue. The SRS FFA Community Involvement Plan (WSRC 2006e) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. SCHWMR R.61-79.124 and Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action and provide the public an opportunity to participate in the selection of the remedial action.

SCHWMR R.61-79.124 requires that a brief description and response to all significant comments be made available to the public as part of the RCRA Administrative Record. Community involvement in consideration of this evaluation of alternatives for the MAOU is strongly encouraged. All submitted comments will be reviewed and considered. Following the public comment period, a Responsiveness Summary will be prepared to address issues raised during the public comment period. The Responsiveness Summary will be made available with the final RCRA permit modification and the Record of Decision (ROD). The final remedial decision will be made only after the public comment period has ended and all the comments have been received and considered. The final remedial decision under RCRA will be in the form of a final permit modification, which is made by SCDHEC. Selection of the remedial alternative that will satisfy the FFA requirements will be made by USDOE, in consultation with USEPA and SCDHEC. It is important to note that the final action(s) may be different from the preferred alternative discussed in this plan depending on new information or public comments. The alternative chosen will be protective of human health and the environment and comply with all federal and state laws.

**Background**

SRS occupies approximately 310 square miles of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina. SRS is located approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina.

SRS is owned by the USDOE. Management and operating services are provided by Washington Savannah River Company (WSRC). SRS has historically produced tritium, plutonium, and other special nuclear materials for national defense. Chemical and radioactive wastes are byproducts of nuclear material production processes. Hazardous substances, as defined by CERCLA, are currently present in the environment at SRS.

## II. COMMUNITY PARTICIPATION

The FFA Administrative Record File, which contains the information pertaining to the selection of the response action, is available at the following locations:

U.S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

Hard copies of the SB/PP are available at the following locations:

Reese Library
Augusta State University
2500 Walton Way
Augusta, Georgia 30910
(706) 737-1744

Asa H. Gordon Library
Savannah State University
Tompkins Road
Savannah, Georgia 31404
(912) 356-2183

The RCRA Administrative Record File for SCDHEC is available for review by the public at the following locations:

The South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management
8911 Farrow Road
Columbia, South Carolina 29203
(803) 896-4000

The South Carolina Department of Health and Environmental Control – Region 5
Aiken Environmental Quality Control Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 641-7670

The public will be notified of the public comment period through the SRS Environmental Bulletin, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell People-Sentinel*, and *The State* newspapers. The public comment period will also be announced on local radio stations.

USDOE will provide an opportunity for a public meeting during the public comment period if significant interest is expressed. The public will be notified of the date, time, and location. At the meetings, the proposed action will be discussed, and questions about the action will be answered.

To request a public meeting during the public comment period, to obtain more information concerning this document, or to submit written comments, contact one of the following:

Paul Sauerborn
Washington Savannah River Company LLC
Public Involvement
Savannah River Site
Building 730-1B
Aiken, South Carolina 29808
(803) 952-6658
paul.sauerborn@srs.gov

The South Carolina Department of Health and Environmental Control
Attn: Richard Haynes, P.E., Director
Division of Waste Management
Bureau of Land and Waste Management
2600 Bull Street
Columbia, South Carolina 29201
(803) 896-4000

Following the public comment period, a ROD will be signed, and a final decision for the SRS RCRA permit will be issued. The ROD and RCRA permit will detail the remedial alternative chosen for this operable unit (OU) and include responses to oral and written comments received during the public comment period in the Responsiveness Summary.

## III. OPERABLE UNIT BACKGROUND

SRS produced special nuclear materials for the Department of Defense between 1952 and 1988. An important step in the production cycle was the manufacture of fuel and target assemblies in M Area for the nuclear reactors. M Area consisted of three major production buildings (313-M, 320-M, and 321-M) that began operation in the early 1950s and continued operation at various production levels until the early 1990s. In addition to the production facilities, three production support facilities (322-M, 324-M, and 340-M) were also located in this area. Southern portions of the MAOU were used as salvage yards (740-A, 743-A, and 741-A). The Liquid Effluent Treatment Facility (LETF) (341-M, 341-1M, and 341-8M) is located southeast of the Production

Area. The Test Reactor Area is east of the LETF in the southern portion of the MAOU and housed two buildings (305-A and 777-10A) to determine appropriate properties of fuel element and target assemblies. There were also warehouses (330-M and 331-M) used to store slugs of depleted uranium. Also, several miscellaneous facilities and electrical transformers are a part of this operable unit. Most of these facilities had a history of managing radioactive material.

The manufacturing processes in M Area consumed a large quantity of industrial cleaning solvents and water, and early practices were to discharge the spent solvents and water directly into the environment. Of the reported 3.5 million lbs. of solvents discharged, approximately 2 million lbs. was discarded to the M-Area Settling Basin located south of M Area via a process sewer line. The basin was closed with the installation of a protective cap in 1991 as required by the RCRA Closure Plan. The portion of the process sewer line outside of the former M Area fence leading to the basin was removed and placed in the basin as part of this closure.

Groundwater is not considered part of the scope for the MAOU. Any groundwater contamination resulting from the MAOU is being addressed as part of the SRS RCRA Part B Permit. A corrective action program for A/M Area vadose zone and groundwater has been in place for over a decade under the RCRA Part B Permit. The baseline technologies for removing contamination are soil vapor extraction (SVE) for the vadose zone sources and pump and treat for groundwater. Also, Dynamic Underground Stripping (DUS) (steam heating) is currently used to address large volumes of solvents in the vadose zone and groundwater.

M Area is designated as an underground radioactive material area (URMA). An URMA is any area, regardless of concentration, that has or is believed to have manmade underground radiological contamination. Some URMAs were well-defined and easy to post (e.g., seepage basins) while others were more complex due to the number of underground process lines. For this reason, radiological control operations (RCO) management decided to post each area fence perimeter (e.g., M Area) as an URMA because the exact location was unknown. This conservatism ensured that RCO was informed of digging activities within the fence area. The fence perimeter of M Area was subsequently removed due to deactivation and decommissioning (D&D) activities. At the M-Area URMA, current controls include signage indicating the area designation as an URMA and administrative controls such as use controls and work clearance. Following closure of the M-Area, institutional controls as outlined later in this document will be implemented to adequately control the URMA.

The M Area at SRS is located in an area of historically heavy industrial and nuclear land use. *The Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates M Area for future industrial, non-residential use. Remedial action objectives (RAOs) and likely response actions were developed consistent with future industrial non-residential land use. This area will require institutional controls to restrict use due to the large area of vadose zone and groundwater contamination, including operation of remedial systems, and the identification of a large part of the area as an URMA. Appropriate land use controls (LUCs) against unrestricted and/or residential use will be part of all remedial actions for the MAOU. The entire area will be limited to industrial use, and it is reasonable to assume that portions of the area will have further restrictions.

M Area is the second OU at SRS to be addressed under an area-wide remedial strategy. As part of this strategy, RCRA/CERCLA/Site Evaluation (SE) units and Deactivation and Decommissioning (D&D) facilities (or remnants) in the former M-Area industrial area were consolidated into the single MAOU.

The MAOU is located in the northwest portion of SRS and covers approximately 45 acres. For evaluation purposes the MAOU was divided into four distinct areas based on the historical operations at the unit. These areas are the Production Area, the Liquid Effluent Treatment Facilities, Test Reactor Facilities, and the Salvage Area.

The investigation areas of the MAOU are depicted on Figure 2 and include SE units and facilities that have been combined based on physical location and common problems warranting action:

- Production Area: 313-M, 321-M (including Underground Sumps #001 and #002), 320-M, 322-M, 340-M, and 324-M (including the northern portions of the M-Area Inactive Process Sewer Line (MIPSL) and associated feeder lines)
- Liquid Effluent Treatment Facilities: 341-M, 341-1M, and 341-8M
- Test Reactor Facilities: 305-A and 777-10A
- Salvage Area: 740-A, 743-A, and 741-A
- Warehouses: 330-M and 331-M
- Miscellaneous Buildings
- Electrical Transformers

The northernmost portion of the MAOU contains the Production Area, which has the earliest history of use. Special nuclear material for the Department of Defense was produced in this area between 1952 and 1988.

The following major facilities were used in this capacity:

- Building 313-M – Used for the production of reactor target assemblies
- Building 320-M – Used for the fabrication of the reactor fuel
- Building 321-M – Used to produce the lithium-aluminum tubes for the target assemblies

All of these buildings used industrial cleaning processes for cleaning the products during the production process, and there are a series of industrial process sewer lines that took the discarded cleaning products (trichloroethylene [TCE], tetra-chloroethylene [PCE], and trichloroethane [TCA]) from these buildings to the M-Area Settling Basin. As previously discussed, the portions of the process sewer lines associated with these buildings were included with the Production Area Evaluation although characterization of the discharge portions of the process sewer lines was completed under the MIPSL OU. The MIPSL OU has a separate ROD

(WSRC 2007f) and remedial path, which includes access controls (grouting of manholes) and management of volatile organic compound (VOC) contamination in the vadose zone by SVE with soil fracturing.

The Liquid Effluent Treatment Facilities is south-southwest of the Production Area. This facility was built in 1988 and all of the liquid effluent was sent to this treatment facility. This facility contained buildings that were used to treat the wastewater stream, package and store the residue from the treatment, and to treat the residue.

The Test Reactor Facilities are east of the Liquid Effluent Treatment Facilities. This area housed two buildings (305-A and 777-10A) that contained small test reactors used to determine the appropriate properties for the fuel elements and the target assemblies before a new model was placed into production.

The southern portions of MAOU were used as the 741-A Salvage Area, and excess materials and equipment were stored on an approximate two-acre portion. The salvage yard contained support facilities for the personnel involved in the management of the excess material. In addition, Building 740-A was used to recondition non-nuclear material. This reconditioning involved painting and cleaning with solvents.

The 330-M Slug Warehouse and 331-M Core Storage Warehouse were used to store slugs of depleted uranium. The inventory of depleted uranium was removed prior to decommissioning. 330-M and 331-M were dismantled and removed during the summer of 2003. No radiological waste was generated during the dismantling of these buildings. The "Radiological Control Basis Radiological Release of 330-M and 331-M" document states: "Based on the process history, radiological history, source term's form, characteristics and containment, and regulatory requirements, the 330/331-M physical structure requires no radiological surveys for general site or public use."

Radiological Control surveyed the 330-M and 331-M pad and found no detectable radiation in the survey. The 330-M and 331-M facilities underwent D&D prior to the current Facilities Decommissioning Evaluation (FDE) process. The MAOU Core Team agreed that, based on process history and the results of the radiological screening, each facility would follow the Simple Model. The WSRC 1C Facility Disposition Manual defines the Simple Model as appropriate for clean buildings with only normal safety risks associated with decommissioning. Therefore, these facilities did not require sampling. There are no problems at the Warehouses that require a remedial action.

Multiple electrical transformer pads remain throughout M Area. Many of these transformer pads are included in the scope of major facility decommissioning. A potential concern with transformers is that polychlorinated biphenyls (PCBs) were used at SRS in dielectric fluids in electrical equipment. After the PCB Disposal Regulations were promulgated in 1978, the SRS conducted a comprehensive evaluation of PCB use. Detailed inventories of PCB-containing equipment were compiled. Where feasible, transformers with high concentrations of PCBs were replaced with non-PCB models. Other pieces of equipment were rendered non-PCB via treatment or a drain-and refill process. The equipment was subsequently tested to verify that it contained less than 50 parts per million (ppm) PCBs. In 1986, USEPA performed a detailed assessment of the SRS compliance with the Toxic Substances Control Act (TSCA) and found records of analysis, storage, and disposal of PCB materials to be in compliance. In 1995, SRS determined that all of the site's transformers and large capacitors that were regulated due to PCB content had been replaced or rendered non-PCB.

There are no records indicating a spill or release from the M-Area transformers while they were operated with PCB oil; therefore, no samples were collected during decommissioning. There are no problems at the electrical transformers that require a remedial action.

Approximately 60% of the inactive process sewer lines in M Area were addressed either through the RCRA Closure Plan or are included in the MIPSL OU. The MAOU Core Team, consisting of representatives from the USEPA, SCDHEC, and USDOE, agreed that although the MIPSL OU should remain on a separate administrative path, remedial actions for the MIPSL OU and MAOU projects should be consistent for similar problems. In 2005, the MAOU Core Team determined that it would be more effective to evaluate some portions of the MIPSL OU as part of the MAOU project. The MAOU Core Team agreed that the inactive process sewer lines (IPSLs) in the northern section of the MIPSL OU and those portions from Manhole 6A to the 322-M building would be added to the scope of the MAOU (Figure 3). The evaluation and analysis for these selected IPSLs was documented in the *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan, RFI/RI Report with Baseline Risk Assessment (BRA) and Corrective Measures Study/Feasibility Study (CMS/FS) for M Area Operable Unit (U)* submitted in July 2006 (WSRC 2006d). This document will be referred to as the MAOU Combined Document throughout the SB/PP.

Site Characteristics

SRS sits atop the Atlantic Coastal Plain Physiographic Province, a seaward-thickening wedge of unconsolidated and semi-consolidated sediments that rests unconformably on underlying Triassic-age sediments and Precambrian to Paleozoic crystalline basement rocks. The sedimentary sequence at SRS ranges from approximately 200 to 275 m (650 to 900 ft) thick, comprising late Cretaceous to Holocene age clastic and calcareous sediments deposited during a series of transgressions and regressions in depositional environments ranging from fluvial to marginal marine settings (Aadland et al. 1995; Fallaw and Price 1995; Siple 1967).

The soil in this document were collected from sediments of the Tertiary age (Eocene) Barnwell Group, a 21 m (70 ft) thick deposit of quartz sand, sandy clay, and calcareous sand deposited in a lower delta plain or shallow shelf environment (Aadland et al. 1995). Sediments of the Barnwell Group are exposed at the ground surface in the MAOU, and in the uppermost 6 to 7.5 m (20 to 25 ft) have been extensively reworked and backfilled during operational activities.

The water table exists at a depth of 34 – 36 m (110 - 150 ft) in M Area. The occurrence and flow of groundwater are influenced by the surface physiography and by the texture, composition, and bedding characteristics of the sedimentary sequence. The SRS regional hydrogeology, including aquifer and aquitard characteristics, groundwater flow, relationship to stratigraphic units, surface water and geomorphology, are described in detail in the *Hydrogeologic Framework of West-Central South Carolina* (Aadland et al. 1995).

The soil described in this report were taken from the uppermost part of the vadose zone. This section of unsaturated and semi-saturated sediments from the ground surface down to the water table is approximately 36 m (120 ft) thick beneath the MAOU and includes Eocene age sediments of the Clinchfield, Dry Branch, and Tobacco Road Formations. The Upland Unit (poorly sorted silty, clayey sands and conglomerates) overlies the Tobacco Road Formation and is present across M Area. The uppermost aquifer beneath the MAOU is the Steed Pond aquifer unit; this aquifer is developed in sections of the Black Mingo, Orangeburg, and Barnwell Groups and is approximately 30 m (100 ft) thick in the study area (Figure 4).

The extent to which unit-related contaminants may leach to groundwater is considered in the conceptual site model (CSM) and contaminant migration analysis for the MAOU. However, groundwater itself is not considered as part of the scope for the MAOU. Any groundwater contamination resulting from the MAOU is being addressed as part of the SRS RCRA Part B Permit and associated corrective action agreements.

***Site Characterization***

The MAOU has been the subject of various investigations:

- Sampling of concrete slabs, below grade concrete barriers, and soils in connection with the decontamination and decommissioning of various buildings.
- Sampling of soils adjacent to the inactive process sewer lines as part of the MIPSL OU project.
- Sampling of concrete slabs, below-grade concrete structures and soils beneath the slab, sumps, trenches and process feeder pipelines as part of the MAOU investigation.

The cumulative results from these investigations were used to determine the nature and extent of contamination and identify the problems warranting action. The facilities of the MAOU were evaluated in the MAOU Combined Document (WSRC 2006d).

## IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The USDOE, the owner of SRS, developed a new completion strategy in 2003 for environmental restoration at SRS. The new strategy accelerates the cleanup completion and results in accelerated risk reduction to workers, the public, and the environment. SCDHEC and the USEPA, which serve as the regulatory agencies, are supporting the accelerated cleanup.

A key component of the plan is to implement an area-by-area remediation strategy. Through the planned sequencing of environmental restoration and decommissioning activities, environmental cleanup can be completed for entire areas of SRS. In addressing whole areas, individual units will be consolidated into an expanded area OU to take advantage of characterization data, risk assessments, decommissioning documents, and integrated solutions to effect economies of scale and reduce administrative requirements.

As part of the area-wide remedial strategy, the facilities in the former M-Area industrial area (including the M-Area process sewer lines and feeder lines shown in Figure 3) were consolidated into a single OU, the MAOU. SRS has revised the FFA to include D&D facilities and Area OUs. This information is listed in Appendix C.4, "D&D Facilities (or Remnants) that May Warrant Response Action," Appendix C.5, "Area Operable Units," and Appendix K, "D&D Facilities List." Appendix K consists of Appendix K.1, "D&D Facilities to be Decommissioned," and Appendix K.2, "D&D Facilities (or Remnants) that Require no Further Evaluation (FFA 1993).

A corrective action program for A/M Area vadose zone and groundwater has been in place for over a decade under the RCRA Part B Permit. The baseline technologies for removing contamination are SVE for the vadose zone sources and pump and treat for groundwater. DUS (steam heating) has been, or is being, used to address large volumes of solvents at two locations. The first DUS project was conducted in the Solvent Storage Tank Area in M Area. That project commenced in September 2000 and was completed in September 2001. The second DUS deployment at SRS is near the M-Area Settling Basin. Operations commenced in August 2005 and are expected to continue into early 2010. The following OUs are addressed under the corrective program:

- M-Area Hazardous Waste Management Facility: Lost Lake Aquifer Zone (remediation on-going)
- M-Area Hazardous Waste Management Facility: M-Area Settling Basin (remediation complete)
- M-Area Hazardous Waste Management Facility: M-Area Vadose Zone (remediation on-going)
- M-Area Hazardous Waste Management Facility: A/M Area Groundwater Portion (remediation on-going)

These OUs will continue to be addressed under the RCRA permit and are not considered part of the MAOU.

The following ongoing efforts are following their own administrative path and will not be addressed under the MAOU:

- RCRA Closure Plan facilities (Buildings 315-4M and 316-M) (complete),
- MIPSL OU, and
- Thirty-five SE units that have reached a No Further Action (NFA) decision.

The RCRA/CERCLA/SE units and D&D facilities (or remnants) that are part of the MAOU are listed in Appendix C of the FFA.

In addition, early actions are in progress at the MAOU. These include 1) removal of radionuclides exceeding principal threat source material (PTSM) criteria in slabs, sumps or pipelines soils to the extent practicable (321-M Production Area); 2) removal of radionuclides that present a human health risk on the concrete slabs at Building 313-M, 322-M, 341-1M, and 341-8M (Production Area and LETF, respectively); 3) removal of VOCs exceeding PTSM criteria and significant sources (greater than 50 mg/kg TCE or PCE) in concrete and subsurface soils to the extent practicable (Production Area); and 4) removal and disposal of contaminated soil and gravel (741-A Salvage Yard). These planned early actions are described in the respective Removal Site Evaluation Reports (RSER)/Engineering Evaluation (EE)/Cost Analysis (CA) (WSRC 2006a and 2006b), and herein. See Table 8-1 for a list of all early actions. This SB/PP addresses the preferred final action alternative for the facilities warranting action following implementation of the early actions and re-evaluation of remedial goal options (RGOs).

Because of these removal actions, potential alternatives for VOCs discussed in the MAOU Combined Document were modified or eliminated (Edible Oil with fracturing was eliminated, SVE was modified). Alternatives that are consistent with the post removal action conditions are discussed in detail in Section VII.

## V. SUMMARY OF SITE RISKS

### Conceptual Site Model

The CSM is an objective framework for assessing data pertinent to the investigation. The CSM identifies and evaluates suspected sources of contamination, contaminant release mechanisms, potentially affected media (secondary sources of contamination), potential exposure pathways, and potential human and ecological receptors. Exposure pathways describe the course a chemical or physical agent takes from the source to the exposed receptor. The following five components comprise an exposure pathway:

- source (facility operations, spill, etc.);
- exposure media (concrete, soil, groundwater, etc.);
- exposure point (slab surface, drinking water well, etc.);
- exposure route (external radiation, ingestion, dermal contact, inhalation, etc.);
- receptor (resident, worker, wildlife, etc.).

If any of these elements are missing, the pathway is incomplete and is not considered further in the quantitative risk assessment. A pathway is complete when all five components are present to permit potential exposure of a receptor to a source of contamination. Exposure analysis is important in terms of identifying all potentially complete exposure routes, understanding the nature and extent (as well as fate and transport) of contamination, and developing preliminary remedial alternatives. In a complete pathway, exposure occurs at exposure points that may represent only a small portion of the entire exposure route. If there is no exposure point, then there is no exposure, even if contaminants have been released into the environment.

The MAOU is located in an area of historically heavy industrial and nuclear land use, and only future industrial land use is anticipated. Therefore, the most appropriate receptor for evaluation from a human perspective is the future industrial worker. From an ecological risk perspective, the industrial setting does not provide adequate habitat for community-level impacts.

In general, the primary sources of contamination at the MAOU are due to the facility operations at each of the areas. Spills, leaks, accidental releases, or simply the operation itself has resulted in a release of hazardous and/or radioactive substances. Industrial effluents generated in multiple M-Area facilities and transported through the sewer lines constitute the primary source of contamination. Leaks and other accidental releases of effluent from the sewer lines constitute the release mechanism.

A potentially complete exposure pathway exists for a future industrial worker for the surface (0 to 0.3 m [0 - 1 ft]) of the concrete slab, gravel, or soil. This pathway was evaluated in the human health (HH) risk assessment for each unit.

Subsurface soils, concrete, and building features (e.g., sumps, trenches, pipelines, etc.) that are below the grade (i.e., >0.3 m [1 ft]) of the concrete slab, gravel, or soil offer a potential exposure pathway for a future industrial worker under an excavation scenario. This pathway was evaluated in the PTSM analysis for each unit.

Leaching of contaminants from the contaminated media (concrete, pipeline, soil) to groundwater constitutes a secondary contaminant release mechanism. The potential to leach to groundwater was evaluated in the CM analysis. Ingestion of groundwater offers a potentially complete pathway for human receptors. The ingestion of groundwater may offer a complete pathway for human receptors, but groundwater is not considered as it is regulated under the SRS RCRA Part B Permit.

The CSMs for the MAOU facilities are shown in Figures 5 through 10. Summary results of the CM analysis, HH risk assessment, PTSM evaluation, and refined constituents of concern (RCOCs) based upon pre-early and post-early action conditions are shown in Tables 1 through 4.

The MAOU Combined Document was written to assess the risks posed to HH and the environment by the MAOU (WSRC 2006d). The assessment included quantitative calculations of HH risks, ecological risks, and the threat posed by future leaching to groundwater.

**Summary of Contaminant Migration Evaluation**

A CM analysis was performed to identify CM constituents of concern (CMCOCs). A constituent is identified as a CMCOC if leachability modeling predicts the constituent will leach to groundwater and exceed maximum contaminant levels (MCLs), preliminary remediation goals (PRGs), or risk-based concentrations (RBCs) within 1,000 years. The following post-early action CMCOC results have been identified for the MAOU:

- PCE in soil at the 313-M Solvent Tank Pit
- PCE and TCE in soil underneath the 321-M Tube Cleaning Pit and at MIPSL tie-in, and PCE at Manhole 4A
- TCE at the 320-M tie-in into MIPSL

Pre-early action CMCOCs are shown in Table 4.

**Principal Threat Source Material Evaluation**

Source materials are those materials that include or contain hazardous substances, pollutants, or contaminants that act as a reservoir for migration to groundwater, surface water, or air, or that act as a source for direct exposure. PTSM is defined as those source materials that have a high toxicity or mobility and cannot be reliably contained or present a significant risk to human health or the environment (USEPA 1991). They include liquids and other highly mobile materials such as those released from surface soil due to volatilization or leaching, or materials having high concentrations of toxic compounds. No threshold level of toxicity/risk has been established to define "principal threat." However, treatment or removal alternatives should be considered for source materials when the cumulative risk for the future industrial worker exceeds 1 x $10^{-3}$ for carcinogens or a hazard index (HI) of 10 for noncarcinogens. The identification of PTSM based on mobility is evaluated under the contaminant migration analysis. For the MAOU, the following constituents were identified as PTSM COCs in three Production Area facilities and are being addressed by the removal early actions:

- U-238 (+D) (industrial worker risk = 2.2 x $10^{-3}$) and uranium metal (HQ = 13.2) in concrete media at the 313-M facility.
- U-235 (+D) (industrial worker risk = 1.7 x $10^{-3}$) in concrete media and PCE (industrial worker risk = 9.4 x $10^{-3}$) in soil media at the 321-M facility.
- U-238 (+D) (industrial worker risk = 1.3 x $10^{-3}$), Ra-226 (+D) (risk = 1.7 x $10^{-3}$), K-40 (risk = 1.2 x $10^{-3}$) in concrete media at the 322-M facility. Sludge in pipes at the 322-M contained PTSM levels of U-235 (+D) (risk = 1.8 x $10^{-3}$ ) and U-238 (+D) (risk = 1.7 x $10^{-2}$).

Following completion of the early actions, no radiological PTSM will remain to be addressed by the final remedial action. No PTSM was identified in the Liquid Effluent Treatment Facilities, Test Reactors or the Salvage Yard.

**Summary of Human Health Risk Assessment**

EPA guidance indicates that, when future residential land use is not reasonably anticipated, it is appropriate to focus the baseline risk assessment on more likely future use scenario(s), provided action is taken to insure that risks from residential exposures are prevented. *The Savannah River Site long Range Comprehensive Plan* (USDOE 2000) designates the MAOU as being within the site industrial support area. Therefore, industrial land use is the most likely future land use scenario. Because residual underground contamination will remain at the unit following the removal action that could result in an unacceptable risk to a future resident (reference Table 2), land use restrictions are warranted.

Human health risks were assessed for current and future land use scenarios. The potentially exposed receptor under the current land use scenario is the known on-unit worker. The potentially exposed receptors under the future land use scenario are the hypothetical industrial worker and the hypothetical resident (adult and child). Existing land use controls will ensure protection against unrestricted (i.e., residential) use.

The probable exposure routes for the future industrial worker at the MAOU are ingestion of contaminated media or biota, external radiological exposure, and dermal exposure to contaminated media. The media investigated as the potential concern is surface soil and concrete.

**Current Land Use**

No human health COCs were identified for the current land use scenario (known on-unit worker).

**Future Land Use**

The MAOU combined document (WSRC 2006b) identified the following human health risks:

For the future industrial worker, U-235 (+D) and U-238 (+D) were identified as refined COCs in sporadic concrete slab locations at the following facilities: 313-M, 322-M, 341-1M, and 341-8M.

In the Production Area, HH COCs were identified at three facilities. For the 313-M Slug Production Facility, U-235 (+D) and U-238 (+D) were identified as HH COCs for external exposure to contaminated concrete slab media. These HH COCs (both individual and cumulative) exceed a risk of 1 x $10^{-6}$ for the future industrial worker (total media risk = 9.6 x $10^{-5}$). At the 321-M Fuel Fabrication Facility, U-235 (+D) was identified as HH COC for external exposure to contaminated concrete slab (total media risk = 8.6 x $10^{-5}$). For the 322-M Slug Production Facility, U-235 (+D) and U-238 (+D) were identified as HH COCs with both the individual and cumulative exceeding a risk of 1 x $10^{-6}$ (total media risk = 3.0 x $10^{-5}$).

In the Liquid Effluent Treatment Facilities, HH COCs were identified at two facilities. For the 341-1M Interim Treatment Storage Facility, U-235 (+D) and U-238 (+D) were identified as HH COCs for external exposure to contaminated concrete slab media. These HH COCs (both individual and cumulative) exceed a risk of 1 x $10^{-6}$ for the future industrial worker (total media risk = 1.5 x $10^{-5}$). At the 341-8M Vendor Treatment Facility, U-235 (+D) and U-238 (+D) were identified as HH COCs with both the individual and cumulative exceeding a risk of 1 x $10^{-6}$ (total media risk = 5.9 x $10^{-5}$).

At the Salvage Yard subunit of the MAOU, metals and polyaromatic hydrocarbons (PAHs) were identified as HH COCs in surface soils. These HH COCs included arsenic, Aroclor 1254, Aroclor 1260, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. Individually, these HH COCs exceeded a risk of 1 x $10^{-6}$ for the future industrial worker with a total cumulative media risk of 4.0 x $10^{5}$.

Early removal actions at the 321-M, 313-M, 322-M, 341-1M, and 341-8M facilities targeted removal of U-235 and U-238 to 0.6 pCi/g and 10.0 pCi/g, respectively. The residual risk from this early action results in a reduced total media risk in the range of 7x $10^{-6}$ for the future industrial worker. The early removal action at the Salvage Yard subunit removed all HH COCs. Tables 1 through 4 display a summary of results for both pre-early and post-early actions for each facility.

**Summary of Ecological Risk Assessment**

The purpose of the ecological risk assessment is to document the analysis of the potential for adverse effects associated with exposure to contaminants likely to be present at the unit. An Ecological Assessment Checklist and the CSM indicate that the MAOU does not support adequate ecological habitat. There is neither natural cover nor food or water resources that would attract wildlife receptors. Ecological effects due to the MAOU are unlikely and no further evaluation is required.

**Conclusion**

Following completion of the early actions, only PCE and TCE will remain as CMCOCs at the Production Area (e.g., 313-M, 320-M, and 321-M) in soil. The remedial action selected for the CM Refined Constituents of Concern (RCOC) will be designed to remove PCE and TCE from the soil and prevent additional impacts to the groundwater.

Additionally, after early action removal of sporadic radiological COCs on the concrete surfaces at the 313-M, 322-M, 341-1M, and 341-8M the total media risk is reduced from a range of $1.5 \times 10^{-5}$ to $9.6 \times 10^{-5}$ before removal, to approximately $7 \times 10^{-6}$ after removal.

## VI. REMEDIAL ACTION OBJECTIVES

RAOs are media- or OU-specific objectives for protecting human health and the environment. RAOs usually specify potential receptors and exposure pathways, and are identified during scoping once the CSM is understood. RAOs describe what the cleanup must accomplish and are used as a framework for developing remedial alternatives. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. The following RAOs are identified for the MAOU after completion of the early actions:

- Prevent human exposure to contaminants that present a risk greater than 1E-06 to a futureresident. This RAO applies to all waste units/building remnants in the MAOU.
- Prevent migration of VOCs in building slabs, sumps, or vadose zone to groundwater above MCLs. This RAO applies to Buildings 313-M, 321-M, and 320-M, and the MIPSL associated with these facilities.
  - Building 313-M: PCE in soil media
  - Building 321-M: PCE and TCE in soil media
  - Building 320-M: TCE in soil media

***Remedial Goal Options***

RGOs are typically identified along with RAOs and represent the preliminary media-specific goals that provide a measure that the RAO will be achieved for a selected remedial action. RGOs can be qualitative statements or numerical values often expressed as concentrations in soils or groundwater, or actions (installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO. RGOs become finalized as remedial goals (RGs) after public comment and approval of the SB/PP and are documented in the ROD.

Final RGs will be monitored to determine when the remedial action is complete. RGOs for MAOU subunits with early action scope are identified in the appropriate RSER/EE/CA documents (WSRC 2006a, WSRC 2006b), and herein. Risk-based RGOs for the RCOCs identified for the remaining MAOU subunits are summarized in Table 5. The most restrictive RGO is identified as the lowest of the human health and contaminant migration RGOs for each RCOC. It is based on the industrial land use scenario. Note that a quantitative evaluation based on a future resident scenario was not performed in the risk assessment. However, the entire MAOU will be under institutional controls to prevent future residential land use. Therefore, only RGOs based on an industrial scenario are presented.

In contrast to the most restrictive RGOs, the most likely RGOs also consider a comparison to background levels. Because of the inherently conservative nature of the risk assessment and RGO calculations, it is possible for the risk-based RGO to be less than what occurs naturally in unimpacted background soils. In this case, the RGO defaults to the background concentration in order to be technically practical to achieve. The background concentration is set as the 95$^{th}$ percentile for unimpacted SRS-wide soils (WSRC 2006c, Appendix B-2).

The most restrictive RGOs and most likely RGOs are a good starting point for developing remedial alternatives. Final RGs will be agreed upon by USDOE, SCDHEC, and USEPA concurrent with selection of a remedial action. Final RGs will be documented in the ROD.

A large portion of the contaminated media was and will be managed through early actions with RGs addressed in the RSER/EE/CA documentation. Table 12 provides a list of all MAOU Early Actions/Removal Actions. The activities to achieve the risk thresholds to the extent practicable will be documented in the Removal Action Completion Report. The CM RGOs in Table 5 are calculated based on the waste unit configurations after early actions. The CM RGO in Table 5 is the soil concentration that is not predicted to impact groundwater above MCLs based on the waste unit configuration after early actions.

Per the MAOU Combined Document (WSRC 2006d), the CM RGO is recalculated to determine a concentration that is not predicted to impact groundwater above MCLs after early actions are completed. A summary of the recalculated RGOs is presented in Appendix B.

***Applicable or Relevant and Appropriate Requirements (ARAR)***

Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), requires that remedial actions comply with requirements and standards set forth under federal and state environmental laws.

Specifically, remedies must consider "any promulgated standard, requirement, criteria, or limitation under a state environmental or facility citing law that is more stringent than any Federal standard, requirement, criteria or limitation" if the former is an ARAR for the site and associated remedial activities. SARA requires that the remedial action for a site meet all ARARs unless a waiver is invoked. In addition to ARARs, many federal and state environmental and public health programs include criteria, guidance, and proposed standards that are not legally binding but provide useful approaches or recommendations.

Such information is required to-be-considered (TBC) when RGs are developed.

ARARs include action-specific, location-specific, and chemical-specific requirements:

**Action-specific ARARs** control or restrict the design, performance, and other aspects of implementation of specific remedial activities.

**Location-specific ARARs** reflect the physiographic and environmental characteristics of the unit or the immediate area, and may restrict or preclude remedial actions depending on the location or characteristics of the unit.

**Chemical-specific ARARs** are media-specific concentration limits promulgated under federal or state law. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires the development of health-based, site-specific levels for chemicals where such limits do not exist and where there is a concern with their potential health or environmental effects.

Table 6 summarizes potential ARARs for the MAOU.

## VII. SUMMARY OF REMEDIAL ALTERNATIVES

This section summarizes the remedial alternatives studied in the detailed analysis phase of the MAOU Combined Document (WSRC 2006d) that apply post early action. In accordance with the NCP, it is desirable, when practical, to offer a range of diverse alternatives to compare during the detailed analyses.

The range of alternatives includes options that (1) immobilize chemicals, (2) reduce the contaminant volume, or (3) reduce the need for long-term, onsite management. Some alternatives have been developed that involve little or no treatment yet provide protection to human health and the environment by preventing or controlling exposure to or migration of the contaminants through engineered or institutional controls. Remedial alternatives were developed to address contamination in surface materials and vadose zone soils.

Removal actions were implemented at the MAOU to address the PTSM and significant VOC source contamination. Consequently, edible oils enhanced with soil fracturing was no longer warranted since the removal action addresses that scope of contamination. Therefore, edible oils enhanced with soil fracturing was rejected from further consideration in the SB/PP, and Alternative A-4 is reduced to Passive Soil Vapor Extraction (SVE) and Institutional Controls.

### Alternatives Addressing VOC Contaminated Media

**Alternative A-1. No Action**

**313-M, 321-M, and 320-M**

| | |
|---|---|
| Total Capital Cost | $0 |
| Present-Worth Operations and Maintenance (O&M) Cost | $0 |
| Total Present-Worth Cost | $0 |

The No Action alternative is required by the NCP to serve as a baseline for comparison with other remediation alternatives.

Under this alternative, no efforts would be made to control access, limit exposure, or reduce contaminant toxicity, mobility, or volume. This alternative would leave the MAOU in its current condition with no additional controls. This alternative does not include five-year remedy reviews.

**Alternative A-3. Concrete Cap, Institutional Controls**

**313-M**

| | |
|---|---|
| Total Capital Cost | $316,899 |
| Present-Worth O&M Cost | $235,255 |
| Total Present-Worth Cost | $552,154 |

**321-M**

| | |
|---|---|
| Total Capital Cost | $547,074 |
| Present-Worth O&M Cost | $235,255 |
| Total Present-Worth Cost | $782,329 |

**320-M**

| | |
|---|---|
| Total Capital Cost | $345,946 |
| Present-Worth O&M Cost | $235,255 |
| Total Present-Worth Cost | $581,201 |

This alternative involves the use of a concrete cap to prevent contaminant migration over the 313-M Core Cleaning Solvent Tank Pit. The cover area is 185 $m^2$ (2,000 $ft^2$). Additionally, this alternative involves the use of a concrete cap to prevent VOC contaminant migration at two 321-M locations: the area west of tube cleaning room, and around manhole 4A. The approximate areas of the caps would be 1,393.5 $m^2$ (15,000 $ft^2$) and 232.2 $m^2$ (2,500 $ft^2$) respectively. Also, for 320-M, this alternative involves the use of a concrete cap to prevent exposure to VOC contaminant migration at the MIPSL tie-in area north of manhole 3N. The approximate area of the cap would be 232.2 $m^2$ (2,500 $ft^2$).

This alternative does not allow unlimited use of the area; therefore, institutional controls would be required to restrict excavation of soil at depth, to maintain the caps, and to prevent future residential use. All manholes will be grouted as part of access controls. Figures 12, 14, and 16 show the concrete cover locations for 313-M, 321-M, and 320-M, respectively. Five-year remedy reviews are included in this alternative.

**Alternative A-4. Passive Soil Vapor Extraction, Institutional Controls**

**313-M**

| | |
|---|---|
| Total Capital Cost | $119,635 |
| Present-Worth O&M Cost | $219,369 |
| Total Present-Worth Cost | $339,005 |

**321-M**

| | |
|---|---|
| Total Capital Cost | $932,938 |
| Present-Worth O&M Cost | $350,136 |
| Total Present-Worth Cost | $1,283,074 |

**320-M**

| | |
|---|---|
| Total Capital Cost | $110,484 |
| Present-Worth O&M Cost | $350,136 |
| Total Present-Worth Cost | $460,620 |

SVE is recognized as the presumptive remedy for VOC contamination in the vadose zone. There are many methods for implementing SVE, and its effectiveness is well documented. Note that based on initial technical evaluation, a passive SVE configuration is likely and the alternatives for the MAOU are costed as such.

Passive SVE applications utilizing BaroBall™ wells take advantage of atmospheric pressure fluctuations and the resultant natural pressure gradients that exist between the atmosphere and the vadose zone. If these two zones are directly connected (for example, by a vadose zone well), the pressure differential will result in flow either into or out of the subsurface. WSRC developed and patented the BaroBall™ to exploit this phenomenon, known as barometric pumping. BaroBall™ is a simple check valve that responds to minimal pressure changes, permitting gas to flow out of the well when barometric pressure is lower than the pressure of the soil-gas, but effectively preventing flow in the reverse direction when atmospheric pressure rises. The BaroBall™ significantly increases the effectiveness of barometric pumping by preventing the inflow of air into a venting well when atmospheric pressures reverse, a condition that can reduce contaminant removal by diluting and dispersing the pollutant.

313-M: Passive SVE operation with a BaroBall™ well would be utilized at Core Cleaning Solvent Tank Pit. No other remnant source of VOC contamination above PRG exists at 313-M after the early action activities.

321-M: The early action for 321-M entails auger excavation, removal, and disposal of >50 mg/kg VOC contamination west of the tube cleaning room. The scope of the digging operations involves 2.4 m (8 ft) diameter excavations to approximately 12.8 m (42 ft) below grade (reference Appendix B). These excavations will be backfilled with sandy soil during the early action work to approximately 3.0 m (10 ft) below surface. Next, stockpiled soil from this early action, along with stockpiled soil from the early action for 320-M, will be used to fill above the excavated holes. Perforated pipes would be placed within the stockpiled soil later and connected to a BaroBall™ well. A vapor infiltration control barrier consisting of geosynthetic clay liner (GCL) will be placed on top the stockpiled soil layer and sealed around the BaroBall™ well to prevent daylighting of the SVE operation. Approximately 0.6 m (2 ft) of clean common fill will be provided to bring the area up to the surrounding grade level. The unexcavated contamination and stockpile soils are less than PTSM threshold levels but greater than PRGs. Additionally, this alternative entails the use of passive SVE operation with BaroBall™ wells at manhole 4A.

320-M: The early action at the VOC contaminated soil was excavation, similar to the activity at 321-M, to 9.1 m (30 ft) below grade, with sandy soil backfill and a 2 ft cover of common fill. This alternative will involve passive SVE operation with a BaroBall™ well at the MIPSL tie-in area north of manhole 3N.

Institutional controls will be used to limit access to the area. Physical barriers (e.g., fences), and/or administrative restrictions (e.g., excavation permit restrictions and deed restrictions) will be used to restrict access to, or activities that can be performed at the impacted areas. The institutional control measures are similar for both VOC residual contamination and radiological contamination areas. All manholes will be grouted as part of access control.

Five-year remedy reviews are included in this alternative. Figures 11, 13, and 15 show the SVE locations for 313-M, 321-M, and 320-M, respectively.

**Alternatives Addressing Radiological Contaminated Media**

**Alternatives B-1 through B-5**

All significant radionuclide contaminated concrete slabs have been or are being removed as an early action. Therefore, Alternatives B-1 through B-5 are no longer applicable, and the remaining slabs are manageable with Institutional Controls. The remaining residual radiological contamination at 313-M, 321-M, and 320-M will be covered by the ICs under the previously discussed VOC alternatives. For 322-M, 341-1M and 341-8M their ICs are captured below with the remnant areas.

**MAOU Remnant Areas**

For buildings 322-M, 341-M, 341-1M, 341-8M, 305-A, 777-10A, 340-M, 324-M, 741-A, 740-A, 743-A, and all other remnants of the MAOU, Institutional Controls will be implemented to prevent human exposure to contaminants that present a risk greater than 1E-06 to a future resident. The following costs are presented for no action and Institutional Controls for the MAOU remnant areas.

**Alternative 1. No Action**

| | |
|---|---|
| Total Capital Cost | $0 |
| Present-Worth O&M Cost | $0 |
| Total Present-Worth Cost | $0 |

**Alternative 2. Institutional Controls**

| | |
|---|---|
| Total Capital Cost | $106,920 |
| Present-Worth O&M Cost | $219,369 |
| Total Present-Worth Cost | $326,289 |

## VIII. EVALUATION OF ALTERNATIVES

The NCP [40 CFR 300.430(e)(9)] requires that potential remedial alternatives undergo detailed analysis using relevant evaluation criteria that will be used by decision makers to select a final remedy. The results of the detailed analysis are then examined to compare alternatives and identify key tradeoffs among alternatives.

The statutory requirements that guide the evaluation of remedial alternatives in a CERCLA FS state that a remedial action must:

- Be protective of human health and the environment
- Attain ARARs or define criteria for invoking a waiver
- Be cost effective
- Use permanent solutions to the maximum extent

USEPA has established nine evaluation criteria to address these statutory requirements under CERCLA. The criteria fall into the categories of threshold criteria, primary balancing criteria, and modifying criteria. Modifying criteria (i.e., state or support agency acceptance and community acceptance) will be evaluated after the public comment period on the SB/PP. Evaluation criteria categories and the nine evaluation criteria are listed and explained in the following discussion.

***Threshold Criteria***

Each alternative must meet the following threshold criteria to be selected as a permanent remedy under CERCLA.

1) **Overall protection of human health and the environment** - The overall protection of human health and the environment is evaluated for each alternative on the basis of how the alternative reduces the risk of exposure to contaminants from potential exposure pathways through engineered or institutional controls. Each alternative is examined as to whether it creates any unacceptable short-term risks to human health. In addition, the RCRA criterion specifying control of source releases is evaluated.

2) **Compliance with ARARs** - Remedial actions under CERCLA are required to attain all ARARs. ARARs are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal, state, or local environmental law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Three types of ARARs (chemical-, action-, and location-specific) have been developed to simplify identification and compliance with environmental requirements. Chemical-specific requirements are media-specific and health-based concentration limits developed for site-specific levels of constituents in specific media. These limits establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Action-specific requirements set controls on the design, performance, and other aspects of implementation of specific remedial activities. Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. Location-specific ARARs are restrictions placed on the concentration of hazardous substances for the conduct of activities solely because they occur in special locations. Location-specific ARARs must consider federal, state, and local requirements that reflect the physiographical and environmental characteristics of the unit or the immediate area. Location-specific ARARs were evaluated to determine applicability to the CMS/FS.

***Primary Balancing Criteria***

Primary balancing criteria are factors that identify key tradeoffs among alternatives.

3) **Long-term effectiveness and permanence** - Long-term effectiveness and permanence are evaluated for each alternative on the basis of the magnitude of residual risk and the adequacy and reliability of controls used to manage remaining waste after response objectives have been achieved. Alternatives that offer long-term effectiveness and permanence halt or otherwise mitigate any potential for offsite contaminant transport and minimize the need for future engineered controls. The degree of uncertainty with regard to treatment effectiveness is also evaluated.

4) **Reduction of mobility, toxicity, or volume through treatment** - The statutory preference is to select a remedial action that employs treatment to reduce the toxicity, mobility, or volume of hazardous substances. The degree to which alternatives employ recycling or treatment is assessed, including how treatment is used to address the principal threats posed by the unit.

5) **Short-term effectiveness** - Evaluation of alternatives for short-term effectiveness takes into account protection of remedial workers, members of the community, and the environment during implementation of the remedial action and the time required to achieve RAOs/RGs. Schedule estimates are based on projected availability of materials and labor and may have to be updated at the time of remediation.

6) **Implementability** - Each alternative is evaluated with respect to the technical and administrative feasibility of implementing the alternatives as well as the availability of necessary equipment and services. This criterion includes the ability to obtain services, capacities, equipment, and specialists necessary to construct components of the alternatives; the ability to operate the technologies and monitor their performance and effectiveness; and the ability to obtain necessary approvals from other agencies.

   Construction schedules are based on good weather, the ability to create and receive adequate and authorized access, and the availability of required utilities. All time estimates assume that the selected remedial design, including construction drawings, has been approved, and all negotiations with contractors and regulators have been concluded.

7) **Cost** - Accuracy of present-worth costs is +50/-30 percent according to USEPA guidance. Detailed cost estimates are derived from current information including vendor quotes, conventional cost-estimating guides (e.g., Means Site Work Cost Data), and costs associated with similar projects. Indirect cost percentages for capital, and O&M costs are based upon estimating guidance, technical judgment, site overhead, and regulatory guidance considering the range of scope for an alternative. The cost estimates are included for comparison only and are not intended to forecast actual budgetary expenditures. The actual costs of the project depends on labor and material costs, site conditions, competitive market conditions, final project scope, and implementation schedule at the time that the remedial activities are initiated. In estimating the present-worth costs, a discount rate of 3.9% is used and inflation is assumed to be 0%. Present-worth costs for review of the site remedy every five years are given for each alternative for which residuals remain at the site. Present-worth costs for these items are based on an estimated time frame of operation. Cost estimates are presented in Appendix A.

*Modifying Criteria*

Modifying criteria (i.e., state or support agency acceptance; community acceptance) will be considered during remedy selection.

8) **State or support agency acceptance** - The preferred alternative should be acceptable to state and support agencies. State acceptance criteria is evaluated based on scoping meetings held between USDOE, USEPA, and SCDHEC, and based on comments received on this combined document and are addressed in the final SB/PP.

9) **Community Acceptance** - The concerns of the community should also be considered in

presenting alternatives that would be acceptable to the community. Community acceptance is evaluated based on comments on the SB/PP received during the public comment period. These comments are considered in the final remedy selection for the ROD and the issuance of a RCRA permit modification.

All of the alternatives have been evaluated against the seven CERCLA evaluation criteria that provide the basis for evaluating the alternatives and selecting a remedy (Tables 7 through 11). The purpose of this section is to identify key advantages and disadvantages of each alternative relative to one another and in relation to the two threshold criteria and five primary balancing criteria. Emphasis is placed on the two threshold criteria: overall protection of human health and the environment and compliance with ARARs. However, key tradeoffs between alternatives are identified through a comparative evaluation against the five primary balancing criteria: long-term effectiveness and permanent reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The five primary balancing criteria were assigned subjective values to aid in performing the comparative analyses. The final two modifying criteria – state or support agency acceptance and community acceptance – will be evaluated following the comment period for the SB/PP.

**Alternatives Addressing VOC Contaminated Media**

**Overall Protection of Human Health and the Environment**

With the exception of Alternative A-1, all alternatives are protective of human health and the environment. Alternative A-4 offers the most protection by addressing VOC contamination with passive SVE treatment with Baroball™ technology to prevent contaminant migration. Alternative A-3 is a less aggressive alternative that addresses the VOC contamination with concrete cover systems to prevent water infiltration and minimize contaminant migration. Both Alternatives A-3 and A-4 equally and sufficiently include institutional controls measures for the manholes and remnant areas to limit site access and use.

**Compliance with ARARs**

*Chemical-Specific ARARs.* With the exception of Alternative A-1, all of the alternatives will comply with protection of groundwater ARARs. Alternative A-4 would be the most effective for complying with the chemical ARARS followed by Alternative A-3.

*Location-Specific ARARs.* With the exception of Alternative A-1, all of the alternatives will comply with protection of migratory birds.

*Action-Specific ARARs.* With the exception of Alternative A-1, all of the alternatives would comply with their pertinent ARARs. Both Alternatives A-3 and A-4 would meet air emission requirements, fugitive dust requirements, and hazardous waste management requirements.

**Long-Term Effectiveness and Permanence**

Alternative A-4 offers the greatest degree of risk reduction, long-term effectiveness, and permanence since the migration of VOC contaminants to the groundwater is prevented with SVE treatment. Alternative A-3 has the next highest level of effectiveness and permanence because a concrete cap system would only act as a barrier system and not be as proactive in treating VOC contamination. Alternative A-1 has no long-term effectiveness or permanence.

**Reduction of Toxicity, Mobility, or Volume through Treatment**

Alternative A-4 provides the greatest reduction in toxicity, mobility, and volume through treatment with SVE. Alternative A-3 does not treat the contaminants but offers a barrier system to minimize infiltration and thus contaminant mobility. Alternative A-1 involves no treatment.

**Short-Term Effectiveness**

Alternative A-4 provides the most risk to remedial workers and environment since it involves set-up of SVE well networks. Additionally, at 321-M, earthwork and placement of a geosynthetic cover pose more risk to workers and the environment. Because of the location of MAOU within SRS, there are negligible risks to surrounding communities. Alternative A-3 provides a lesser amount of risk to the remedial workers and environment than Alternative A-4 because it involves placement of concrete cover systems. No remedial activities are associated with Alternative A-1; therefore, no risks to remedial workers, the environment, or community exist.

**Implementability**

Equipment, materials, and skilled labor are readily available to support all of the alternatives. Alternative A-4 has the most complexity due to its constructability of SVE well network and earthwork at 321-M. Alternative A-3 is the most easily implemented due to simple cover system configurations. No implementation is associated with Alternative 1.

**Cost**

Alternative 1, no action, is the least expensive of all the three alternatives to implement. A cost summary of the other alternatives per building is provided in Table 12.

**<u>MAOU Remnant Areas</u>**

For purpose of evaluating the No Action Alternative and Institutional Controls alternative, it is recognized that ICs would offer sufficient overall protection of human health and the environment, control the minimal residual risk, and provide adequate controls. Additionally, ICs would have no risks to the remedial workers, community, and environment, and be easily implemented with a nominal cost.

## IX. PREFERRED ALTERNATIVE

Individual alternatives for the buildings will be combined into the Preferred Alternative for the MAOU in the SB/PP. The Preferred Alternative is the alternative that provides the greatest level of protection to human and ecological receptors in a comparable timeframe as evaluated under the CERCLA Nine Evaluation Criteria in the preceding section. Cost is also considered in the evaluation if the levels of protection of several alternatives are similar. Maturity of the technologies must also be considered.

The preferred alternatives for the MAOU after completion of early actions:

Passive Soil Vapor Extraction, Institutional Controls

Vadose zone remediation using SVE reduces/removes the VOC source, and is typically performed to manage the release of VOCs to groundwater. For example, the groundwater may be contaminated with VOCs above the MCL or the concentrations within the vadose zone are elevated enough to threaten groundwater. SVE is expected to improve groundwater conditions by reducing the further migration of VOCs to groundwater. SVE is a common technology that is implemented to manage the release of VOCs from sources in the vadose zone to prevent impact to groundwater. SVE removes the VOC from the soil by evacuating the soil gas from the contaminated soil. The pressure gradient created by the vacuum causes the soil-gas to flow through the soil pore spaces toward the wells. This remedy has two beneficial aspects. The first is that the remedy focuses on the VOC contamination that has been mobilized and is in the form of soil gas. By removing the soil gas, there is a relatively immediate impact on groundwater since the source of contamination to the groundwater has been cut off. The second benefit is that SVE is a treatment technology that over time reduces the mass of contamination in the subsurface.

This second aspect of the remedy is a key to meeting the RGs that will be established for this remediation. The final RG is a model derived number, and as such does not definitively establish when the threat to groundwater has been mitigated. Every attempt will be made to meet the established RGs as finalized following public comment. The effect of VOC soil contamination on the groundwater depends on multiple factors, including both concentration and mobility. Thus recognized, RGs may not be the sole indicator used to determine when degradation to groundwater has been halted and/or the threat to groundwater has been eliminated. Additional data and information may be used by the Core Team to establish these conditions. SRS believes that it is important to review all the monitoring data, including VOC concentrations in soil, soil-gas extracted by the SVE system, and groundwater concentrations when determining the effectiveness of a particular SVE technology in achieving RAOs.

Institutional controls will be implemented throughout the MAOU and remnant facilities by the following:

- Providing access controls for on-site workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing or health and safety requirements and identification signs located at the waste unit boundaries.

- Notifying USEPA and SCDHEC in advance of any major changes in land use or excavation of waste.

- Providing access controls against trespassers as described in the 2000 RCRA Part B Permit Renewal Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary.

- Grouting all manholes as an access control measure.

In the long term, if the property is ever transferred to nonfederal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of

CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall notify any potential purchaser that the property has been used for the management and disposal of waste.

These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit. The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The preferred remedy for the MAOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As negotiated with USEPA, and in accordance with USEPA - Region IV Policy (*Assuring Land Use Controls at Federal Facilities*, April 21, 1998), SRS has developed a Land Use Controls Assurance Plan (LUCAP) to ensure that land use restrictions are maintained and periodically verified. The unit-specific Land Use Controls Implementation Plan (LUCIP) that will be referenced in the ROD for this MAOU will provide details and specific measures required for the Land Use Controls (LUCs) selected as part of this preferred remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs described in this SB/PP.

The LUCIP, developed as part of this action, will be submitted concurrently with the Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP), as required by the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the MAOU ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect until modified as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

The preferred alternative was selected because it effectively uses treatment to curtail contaminant migration of VOCs.

The alternative provides the best balance of tradeoffs between alternatives because contaminant toxicity, mobility, and volume is reduced. Additionally, less VOC residual contamination remain at the site. Institutional controls are readily implementable and do not increase worker risk. Based upon the information currently available, the lead agency believes that the preferred alternative provides the best balance of tradeoffs with respect to the evaluation criteria.

USDOE expects the preferred alternative to satisfy the statutory requirements in CERCLA Section 121(b) to (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost-effective, and (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The preferred alternative can change in response to public comment or new information.

## X. POST-ROD SCHEDULE

An implementation schedule is provided in Figure 17 showing the ROD date, post-ROD document submittals, and remedial action start date.

## XI. REFERENCES

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## XII. GLOSSARY

**Administrative Record File:** A file that is maintained and contains all information used to make a decision on the selection of a response action under the Comprehensive Environmental Response, Compensation and Liability Act. This file is to be available for public review, and a copy is to be established at or near the Site, usually at one of the information repositories. Also a duplicate file is held in a central location, such as a regional or state office.

**ARARs:** Applicable, or Relevant and Appropriate Requirements. Refers to the federal and state requirements that a selected remedy will attain. These requirements may vary from site to site.

**Baseline Risk Assessment:** Analysis of the potential adverse health effects (current or future) caused by hazardous substance release from a site in the absence of any actions to control or mitigate these releases.

**Characterization:** The compilation of all available data about the waste units to determine the rate and extent of contaminant migration resulting form the waste site, and the concentration of any contaminants that may be present.

**Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 1980:** A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act.

**Corrective Action:** A USEPA requirement to conduct remedial procedures under RCRA 3998(h) at a facility when there has been a release of hazardous waste or constituents into the environment. Corrective action may be required beyond the facility boundary and can be required regardless of when the waste was placed at the facility.

**Exposure:** Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, digestive tract, etc.) and available for absorption.

**Federal Facility Agreement (FFA):** The legally binding agreement between regulatory agencies (USEPA and SCDHEC) and regulated entities (USDOE) that sets the standards and schedules for the comprehensive remediation of the SRS.

**Media:** Pathways through which contaminants are transferred. Five media to which a release of contaminants may occur are groundwater, soil, surface water, sediments, and air.

**National Priorities List:** USEPA's formal list of the nation's most serious uncontrolled or abandoned waste sites, identified for possible long-term remedial response, as established by CERCLA.

**Operable Unit (OU):** A discrete action taken as one part of an overall site cleanup. The term is also used in USEPA guidance documents to refer to distinct geographic areas or media-specific units within a site. A number of operable units can be used in the course of a cleanup.

**Operation and Maintenance (O&M):** Activities conducted at a site after a response action occurs to ensure that the cleanup and/or systems are functioning properly.

**Overall Protection of Human Health and the Environment:** The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

**Proposed Plan:** A legal document that provides a brief analysis of remedial alternatives under consideration for the site/operable unit and proposes the preferred alternative. It actively solicits public review and comment on all alternatives under consideration.

**Record of Decision (ROD):** A legal document that explains to the public which alternative will be used at a site/operable unit. The record of decision is based on information and technical analysis generated during the remedial investigation/ feasibility study and consideration of public comments and community concerns.

**Remedial Goal (RG):** Remedy goals become finalized as remedial goals (RGs) after public comment and approval of the SB/PP and are documented in the ROD.

**Remedial Goal Option (RGO):** Remedial goal options are typically identified along with RAOs and represent the preliminary media-specific goals that provide a measure that the RAO will be achieved for a selected remedial action. RGOs can be qualitative statements or numerical values often expressed as concentrations in soils or groundwater, or actions (installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO.

**Resource Conservation and Recovery Act (RCRA), 1976:** A Federal law that established a regulatory system to track hazardous substances from their generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent the creation of new, uncontrolled hazardous waste sites.

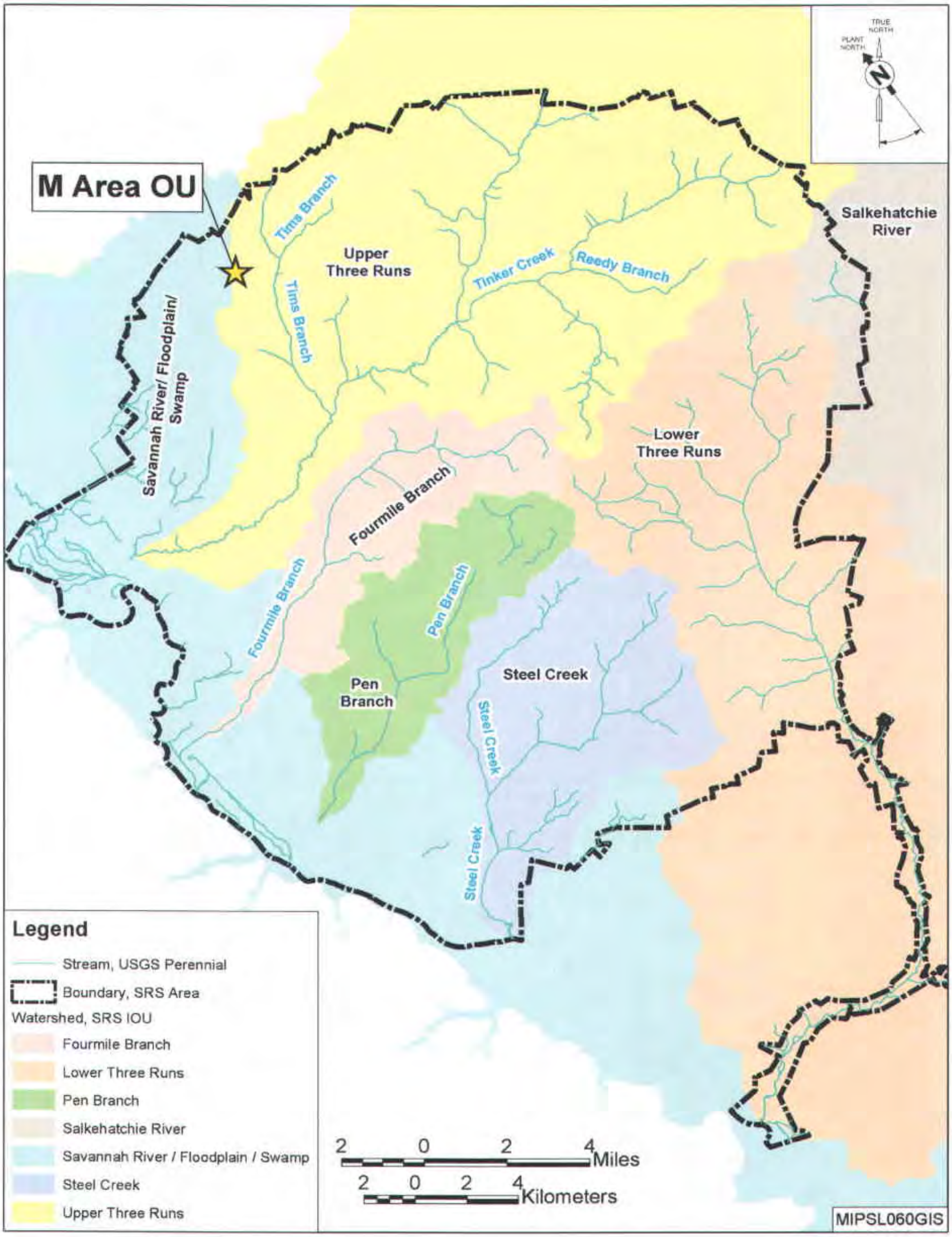
**Responsiveness Summary:** A summary of oral and/or written comments received during the proposed plan comment period and includes responses to those comments. The responsiveness summary is a key part of the ROD, highlighting community concerns.

**Statement of Basis:** A report describing the corrective measures/remedial actions being conducted pursuant to South Carolina Hazardous Waste Management Regulations, as amended.

**Superfund:** The common name used for CERCLA; also referred to as the Trust Fund. The Superfund program was established to help fund cleanup of hazardous waste sites. It also allows for legal action to force those responsible for the sites to clean them up.

**Target Risk Range:** USEPA guidance for carcinogenic risk due to exposure to a known or suspected carcinogen between one excess cancer in an exposed population of ten thousand ($1.0 \times 10^{-4}$) and one excess cancer in an exposed population of one million ($1.0 \times 10^{-6}$). Risks within this range require risk management evaluation of remedial action alternatives to determine if risks can be reduced below one excess cancer in one million ($1.0 \times 10^{-6}$). Risks greater than $1.0 \times 10^{-4}$ indicate that remedial action is generally warranted.

# *FIGURES*




*USGS – United States Geological Survey

**Figure 1. Location of the MAOU within the Savannah River Site**

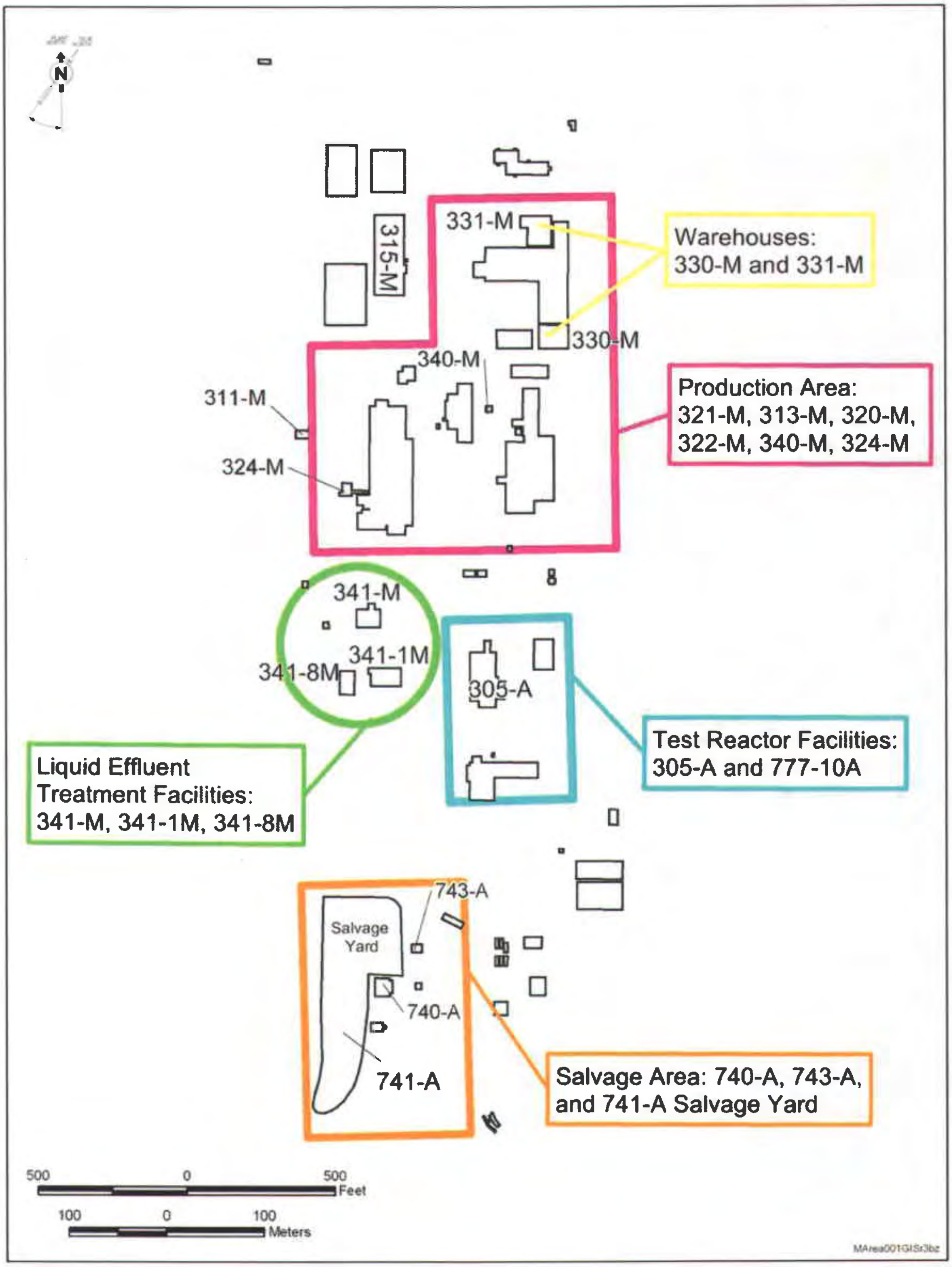



**Figure 2.** **Layout of the MAOU**


Figure 3. M-Area Inactive Process Sewer Line

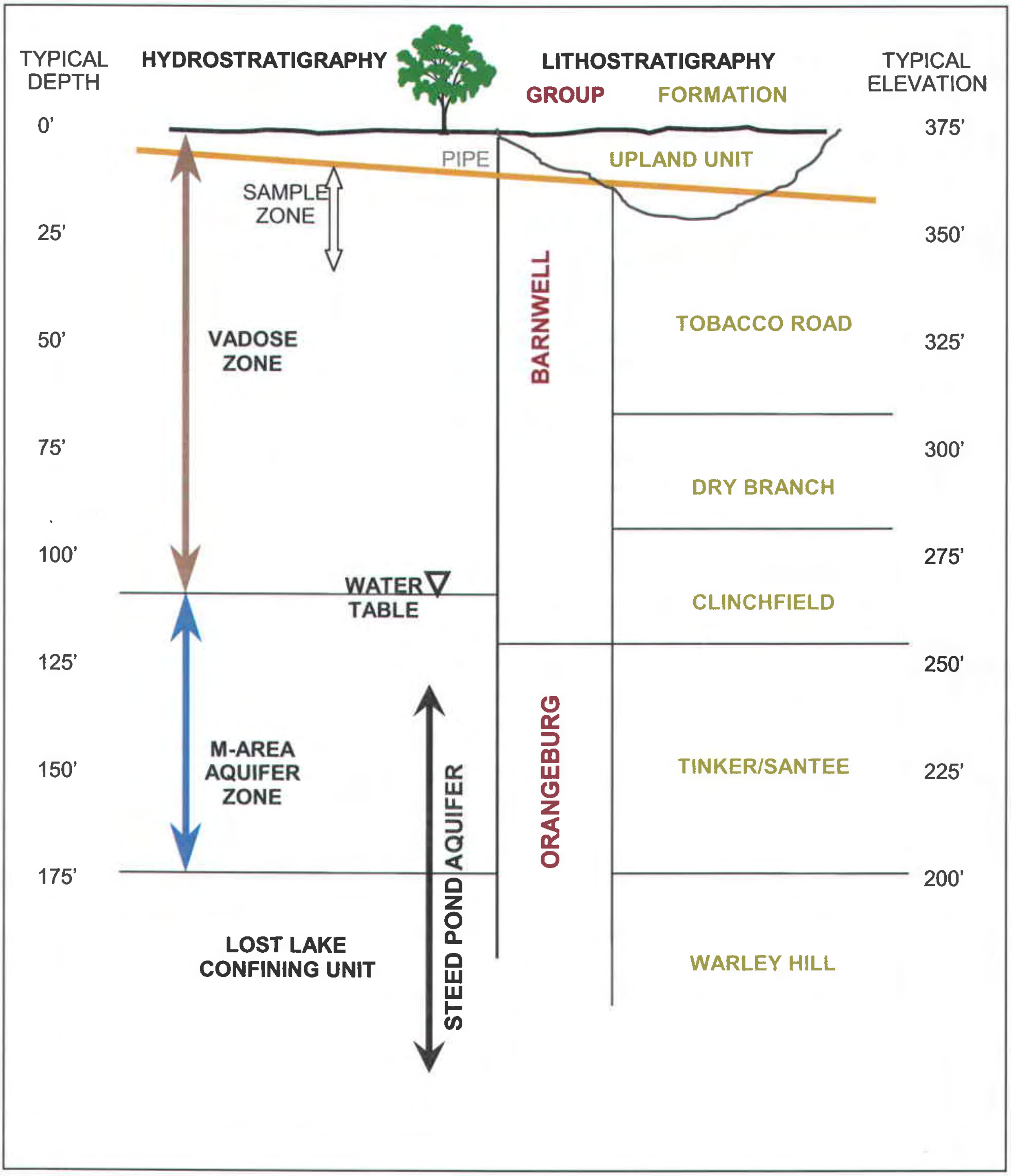
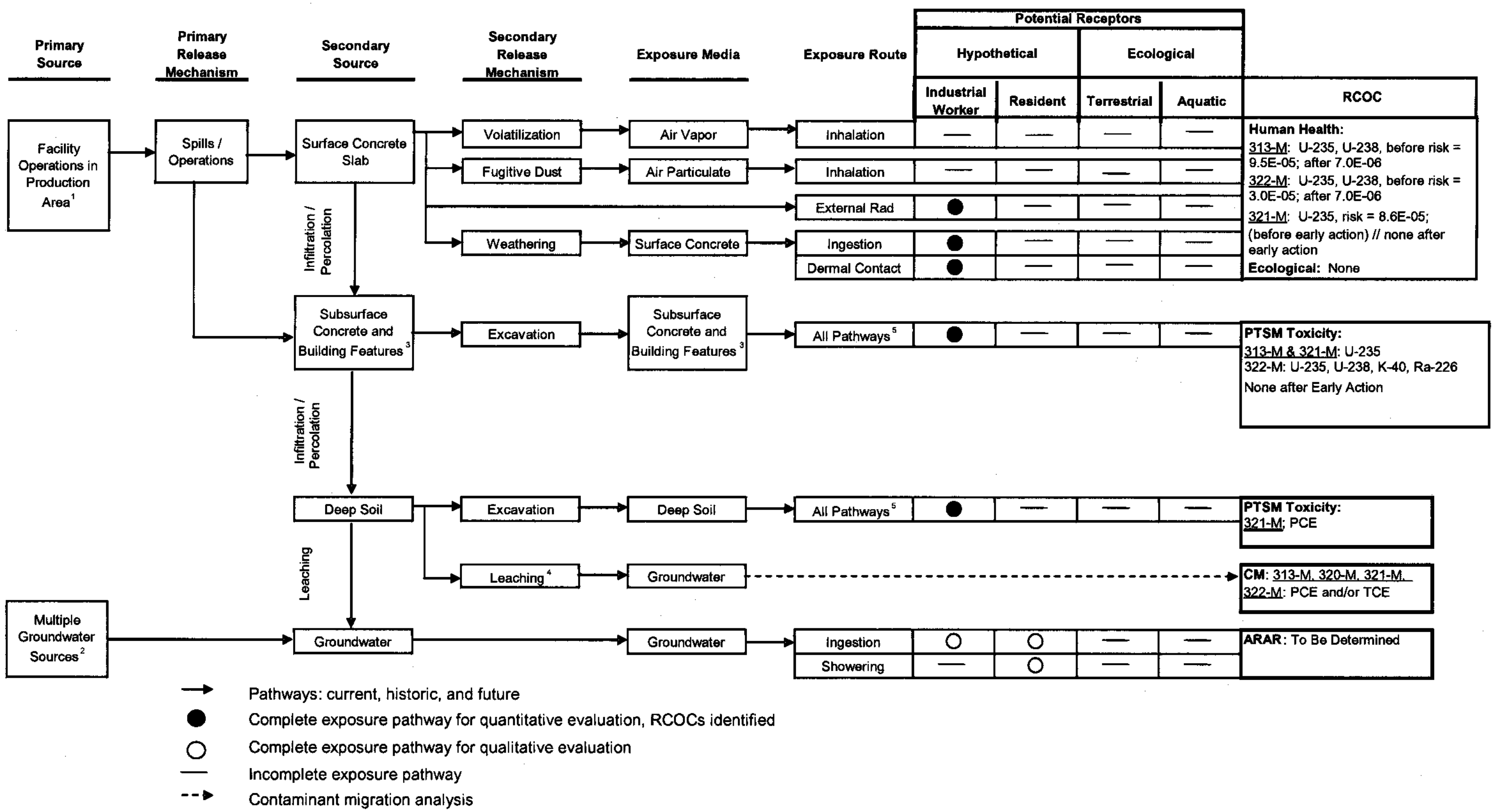
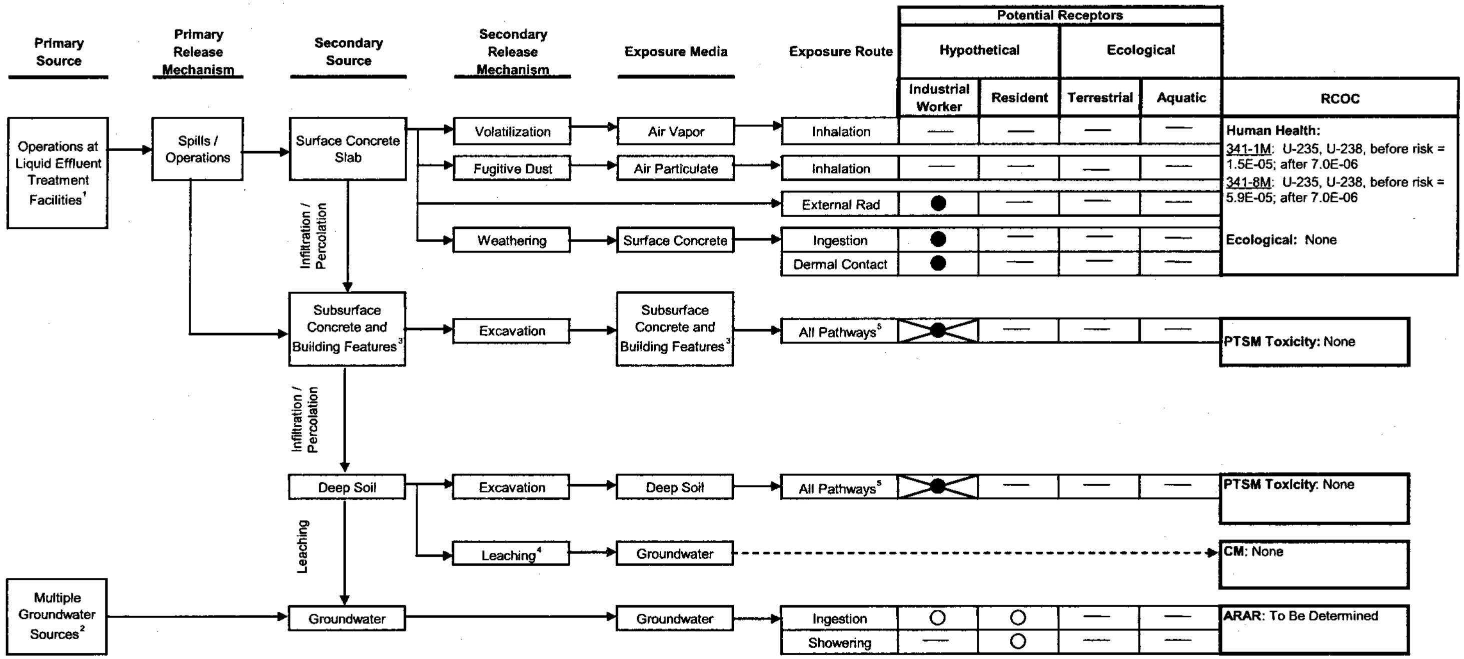



**Figure 4.** **Schematic Cross Section of the MAOU**




1. Production Area facilities include Buildings 313-M, 320-M, 321-M, 322-M, 324-M, 340-M and the inactive process sewer lines in the northern section of the MIPSL OU and those portions from manhole 6A to the 322-M building.
2. Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.
3. Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently below grade of concrete slab.
4. Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)
5. All pathways represent ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM). Evaluation for toxicity.

**Figure 5. Conceptual Site Model for the Production Area**




Pathways: current, historic, and future
Complete exposure pathway for quantitative evaluation, no RCOCs identified
Complete exposure pathway for quantitative evaluation, RCOCs identified
Complete exposure pathway for qualitative evaluation
Incomplete exposure pathway
Contaminant migration analysis

1 Liquid Effluent Treatment Facilities include Buildings 341-M, 341-1M and 341-8M.

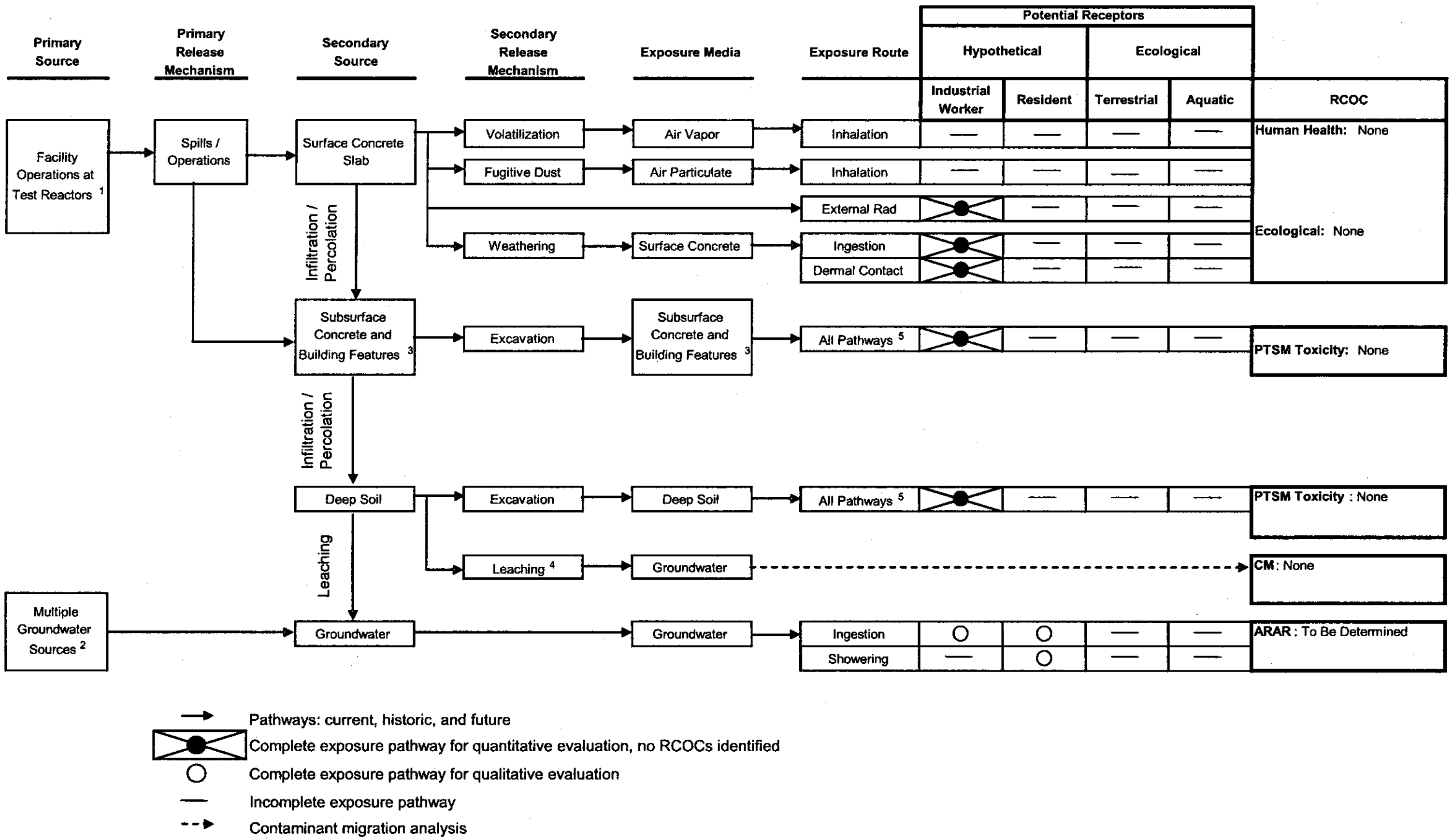
2 Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.

3 Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently below grade of concrete slab.

4 Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)

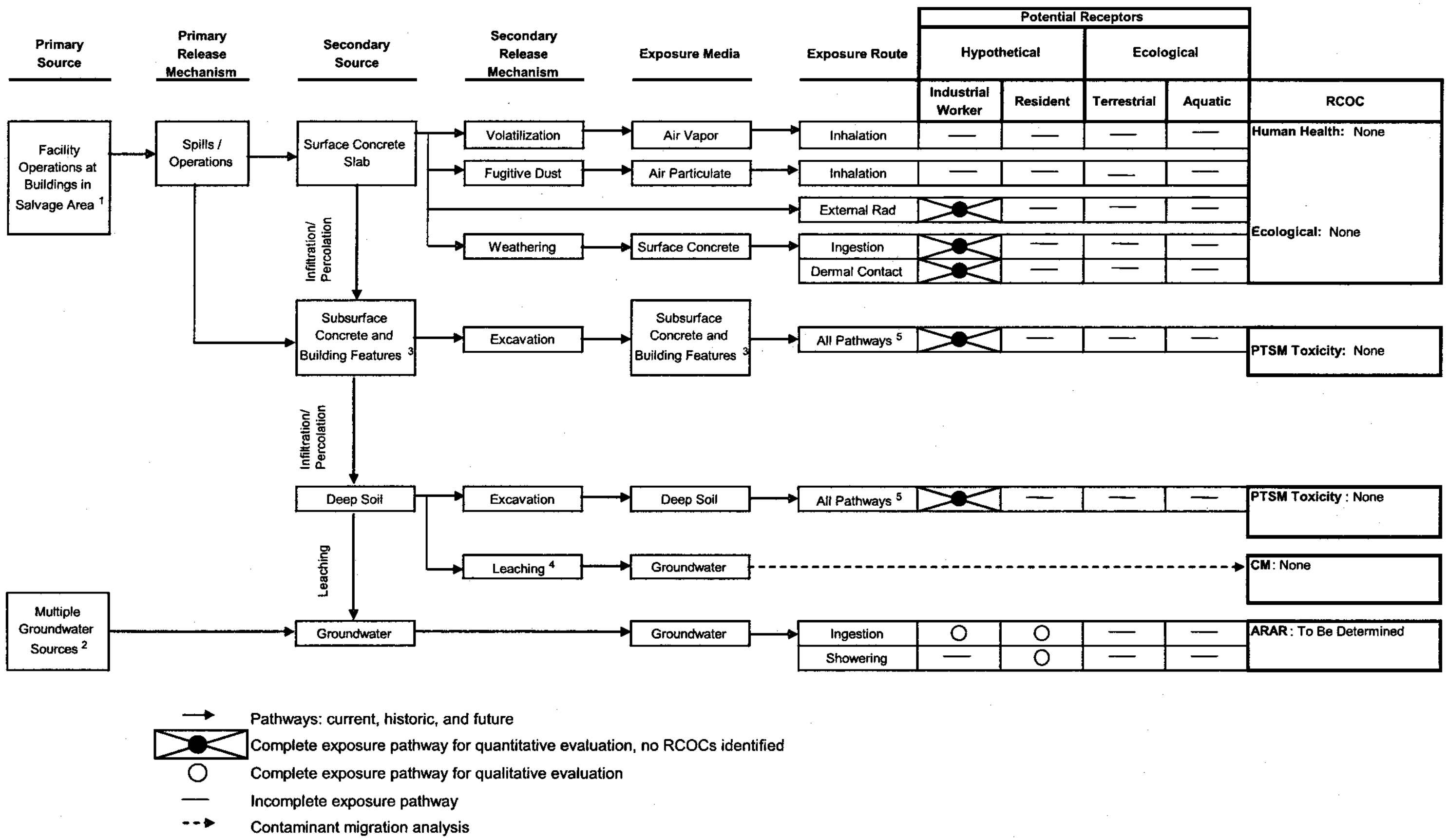
5 All pathways represents ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM) evaluation for toxicity.

**Figure 6. Conceptual Site Model for the Liquid Effluent Treatment Facilities**




1. Test Reactors include Buildings 305-A and 777-10A and associate inactive process sewer lines. Note that 777-10A has no surficial exposure pathways.
2. Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.
3. Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently below grade of concrete slab.
4. Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)
5. All pathways represent ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM). Evaluation for toxicity.

**Figure 7. Conceptual Site Model for the Test Reactors**




1 Salvage Area Buildings include 740-A and 743-A. Note that the 741-1A Salvage Yard is not included in this CSM.

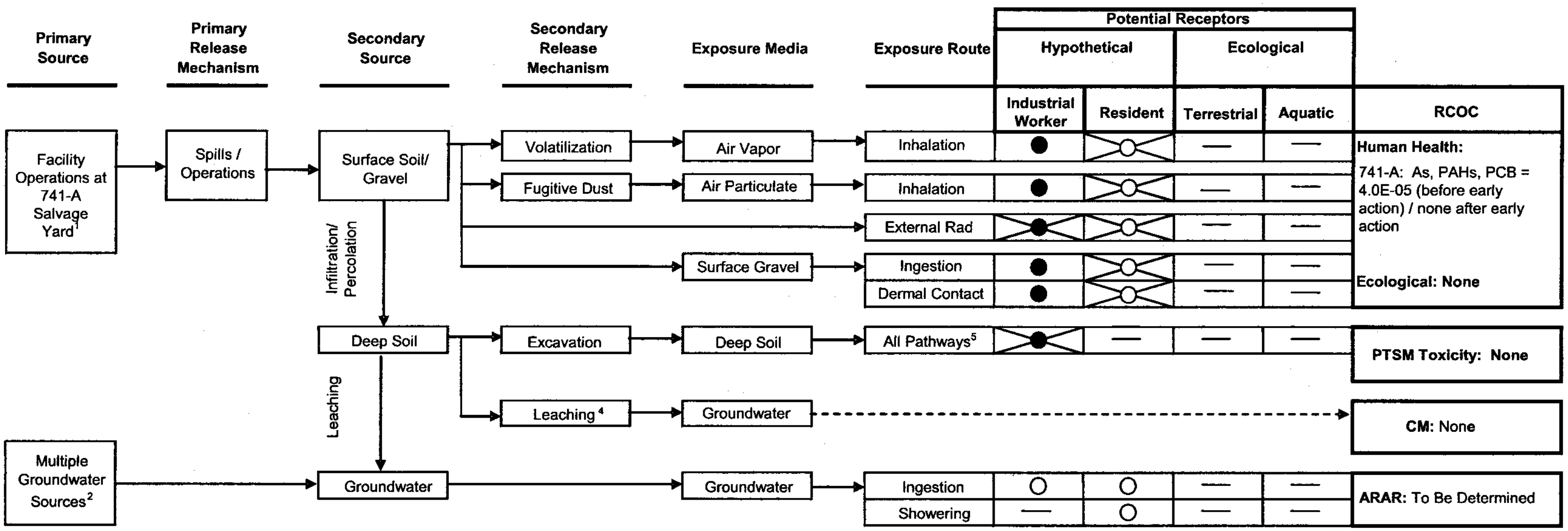
2 Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.

3 Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently below grade of concrete slab.

4 Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)

5 All pathways represents ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM) evaluation for toxicity.

**Figure 8. Conceptual Site Model for the Salvage Area Buildings (740-A and 743-A)**




Pathways: current, historic, and future
Complete exposure pathway for quantitative evaluation, RCOCs identified
Complete exposure pathway for quantitative evaluation, no RCOCs identified
Complete exposure pathway for qualitative evaluation
Complete exposure pathway for qualitative evaluation, no RCOCs identified
Incomplete exposure pathway
Contaminant migration analysis

1 Only the 741-1A Salvage Yard is included in this CSM. The CSM for other buildings in the Salvage Area is depicted in Figure CSM-10.

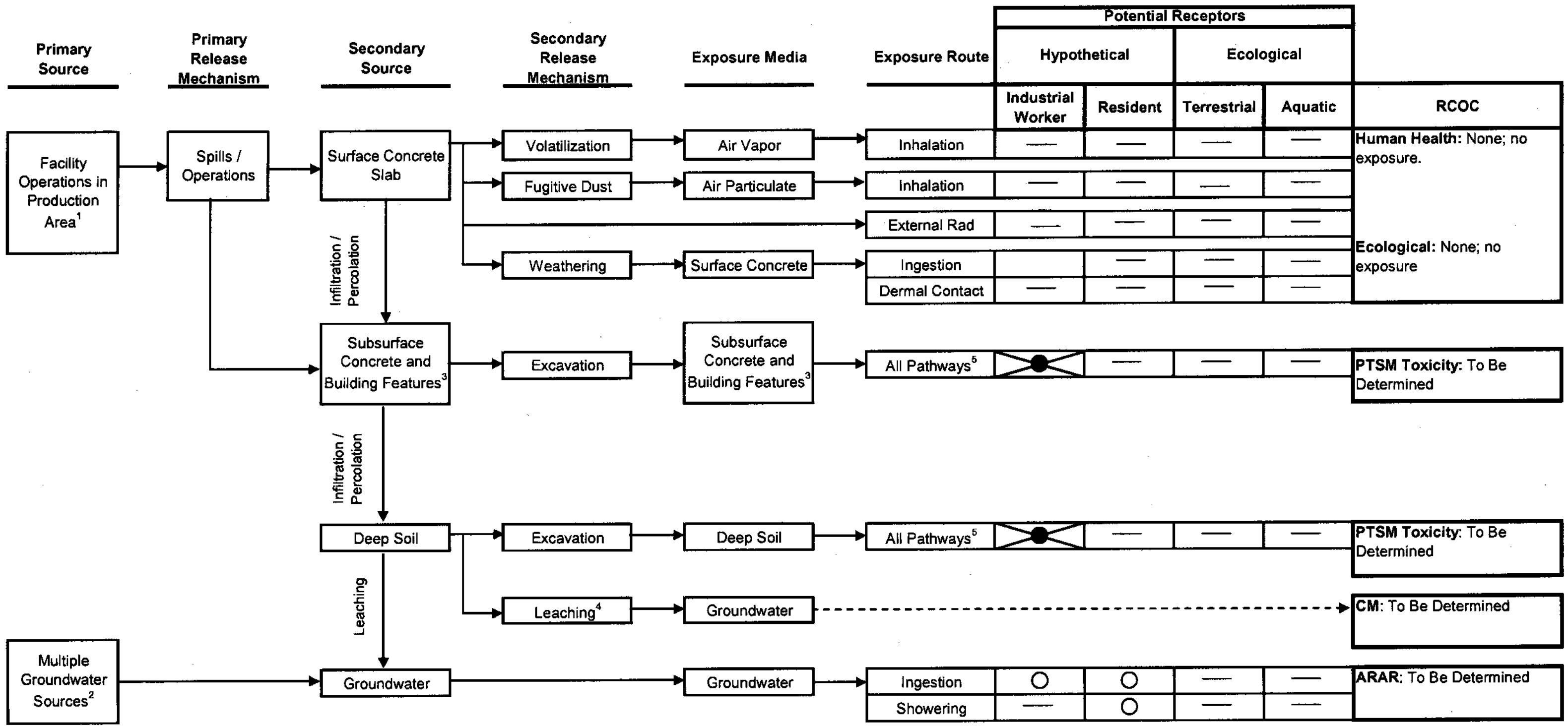
2 Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.

3 Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently underneath the concrete slab (below grade).

4 Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)

5 All pathways represents ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM) evaluation for toxicity.

**Figure 9. Conceptual Site Model for the 741-A Salvage Yard**




Pathways: current, historic, and future
Complete exposure pathway for quantitative evaluation, no RCOCs identified
Complete exposure pathway for qualitative evaluation
Incomplete exposure pathway
Contaminant migration analysis

1 This is CSM is for subunits that have no surficial exposure pathways (340-M, 777-10A).

2 Groundwater has been impacted by multiple sources within M Area and will be addressed under the M-Area RCRA Corrective Action Program.

3 Subsurface concrete and building features includes sumps, trenches, pipelines, etc., that are currently below grade of concrete slab.

4 Leaching represents the potential of a contaminant in deep soil to migrate to groundwater above MCLs per the contaminant migration (CM) analysis. (Does not represent a human or ecological exposure route.)

5 All pathways represents ingestion, inhalation, dermal contact, and external radiation exposure for principal threat source material (PTSM) evaluation for toxicity.

**Figure 10. Conceptual Site Model for the 340-M and 777-10A**

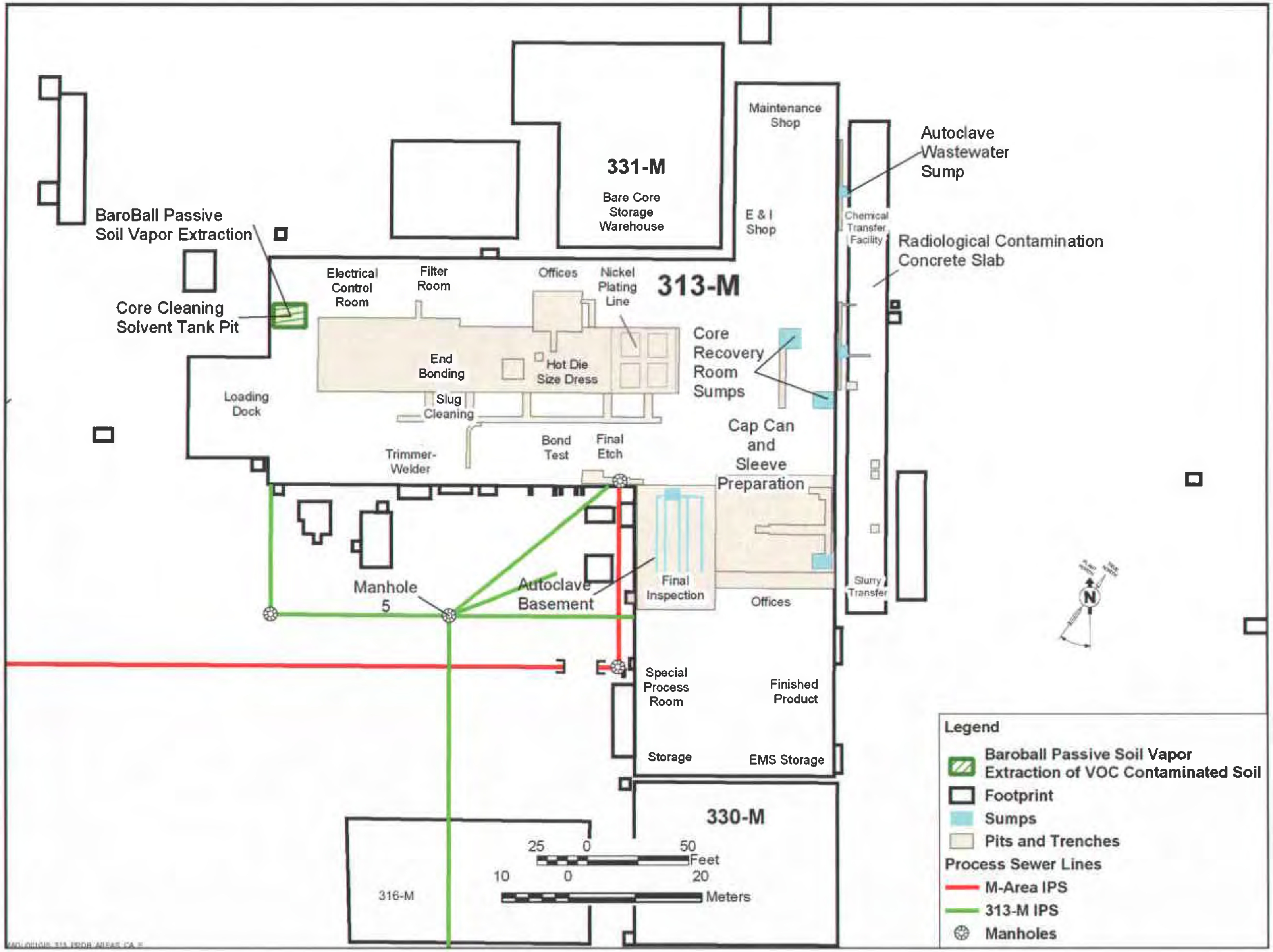



Figure 11. Building 313-M, Alternative A-4

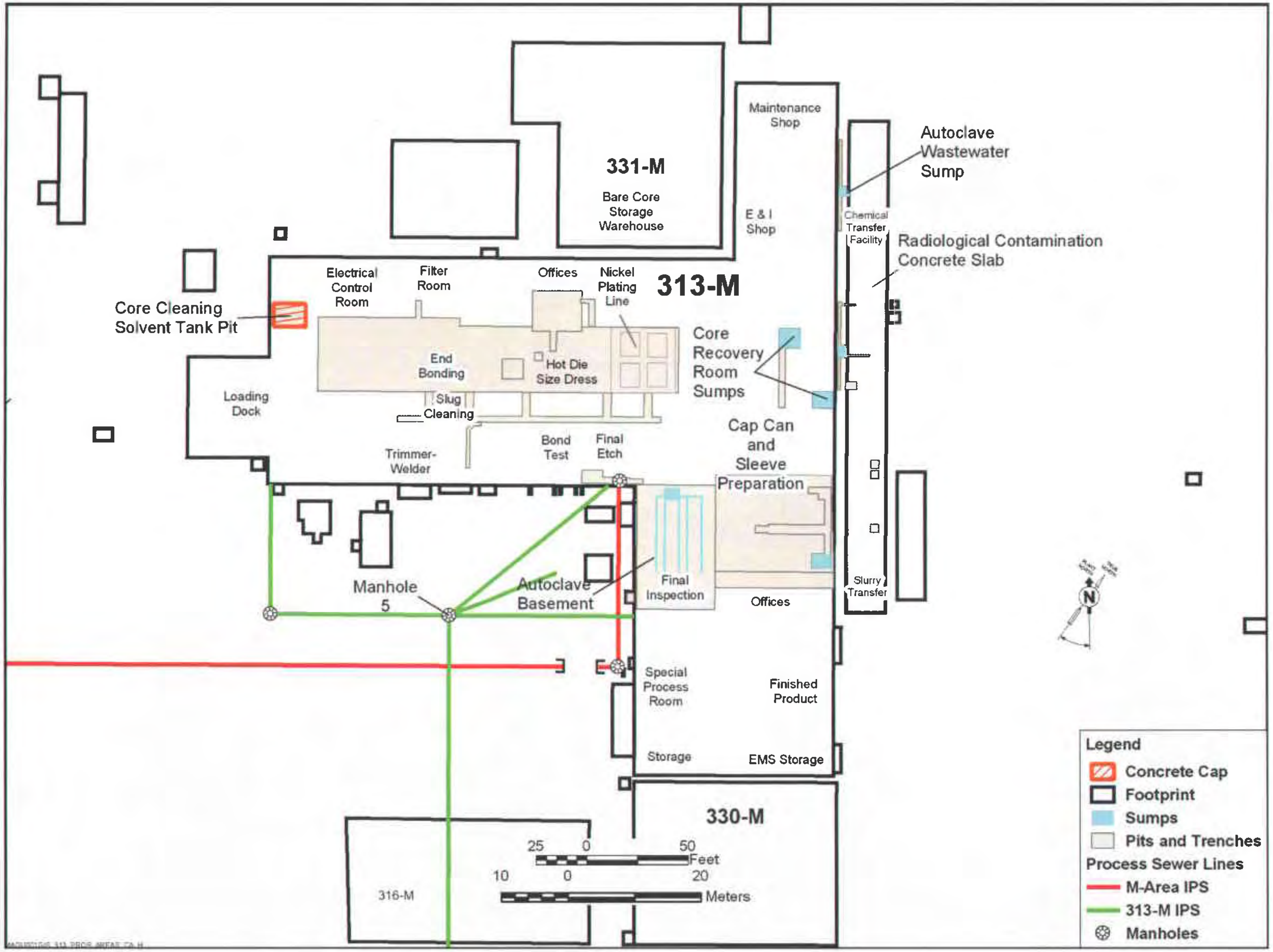



Figure 12. Building 313-M, Alternative A-3

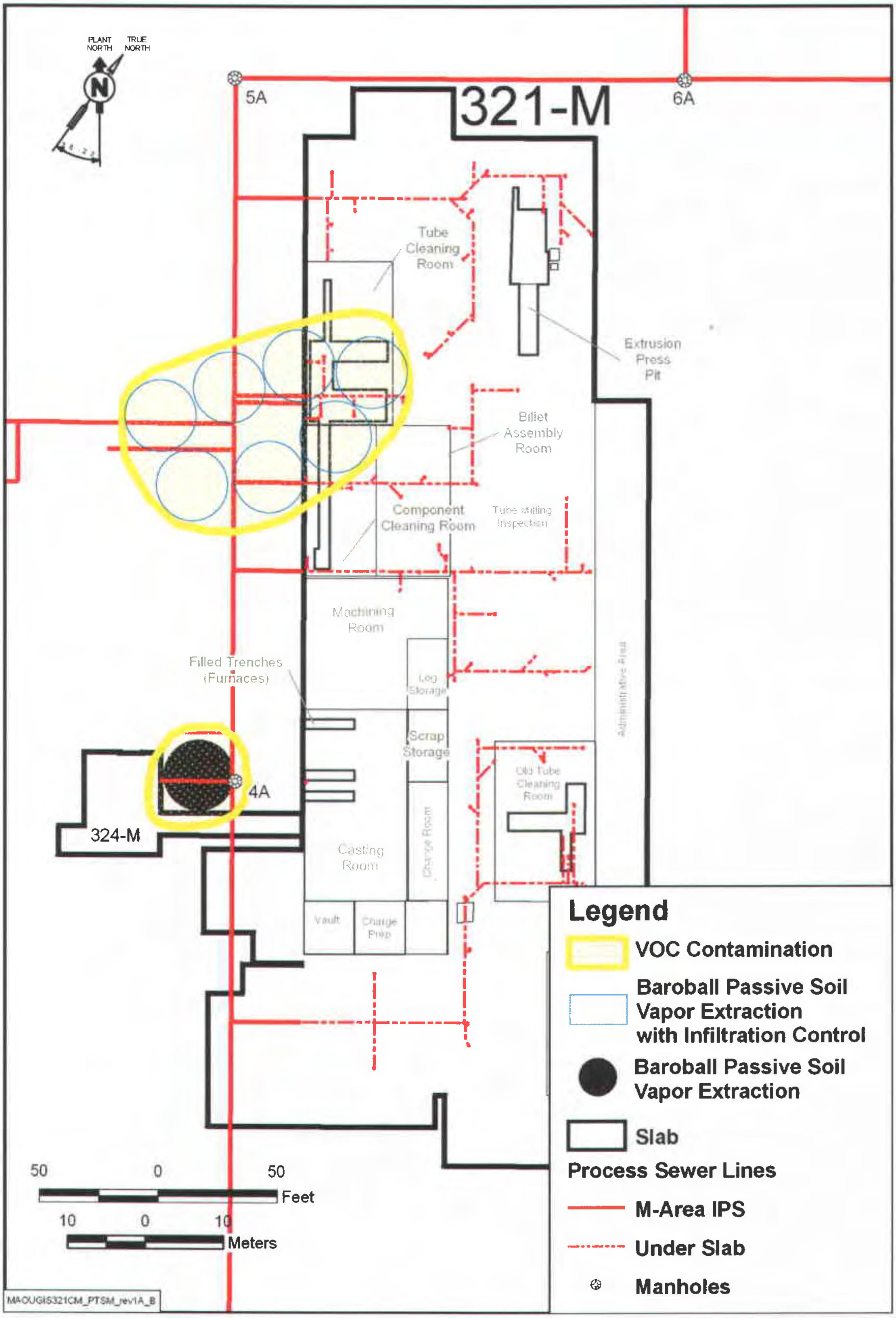



**Figure 13.** Building 321-M, Alternative A-4

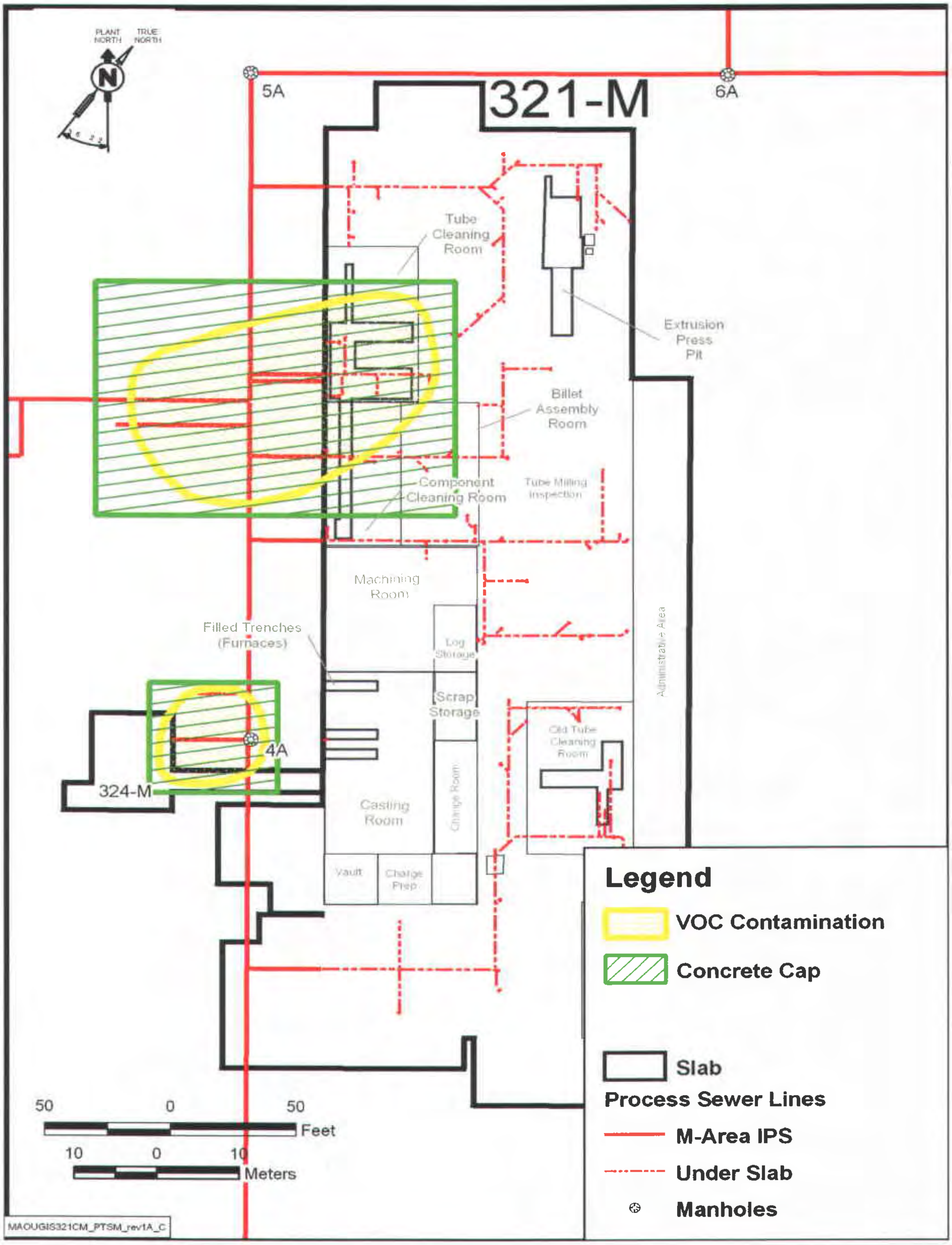



Figure 14. Building 321-M, Alternative A-3

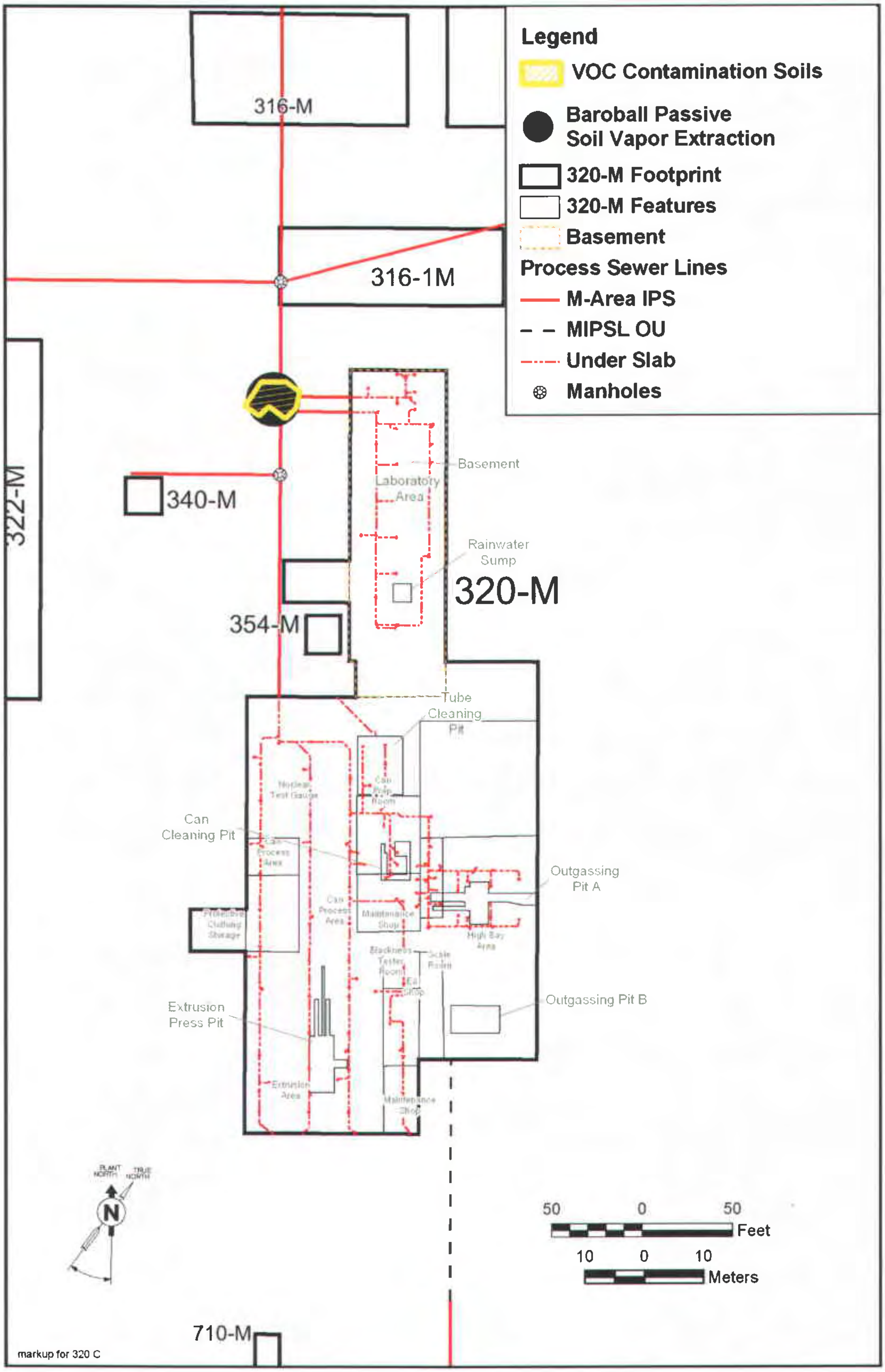



Figure 15. Building 320-M, Alternative A-4

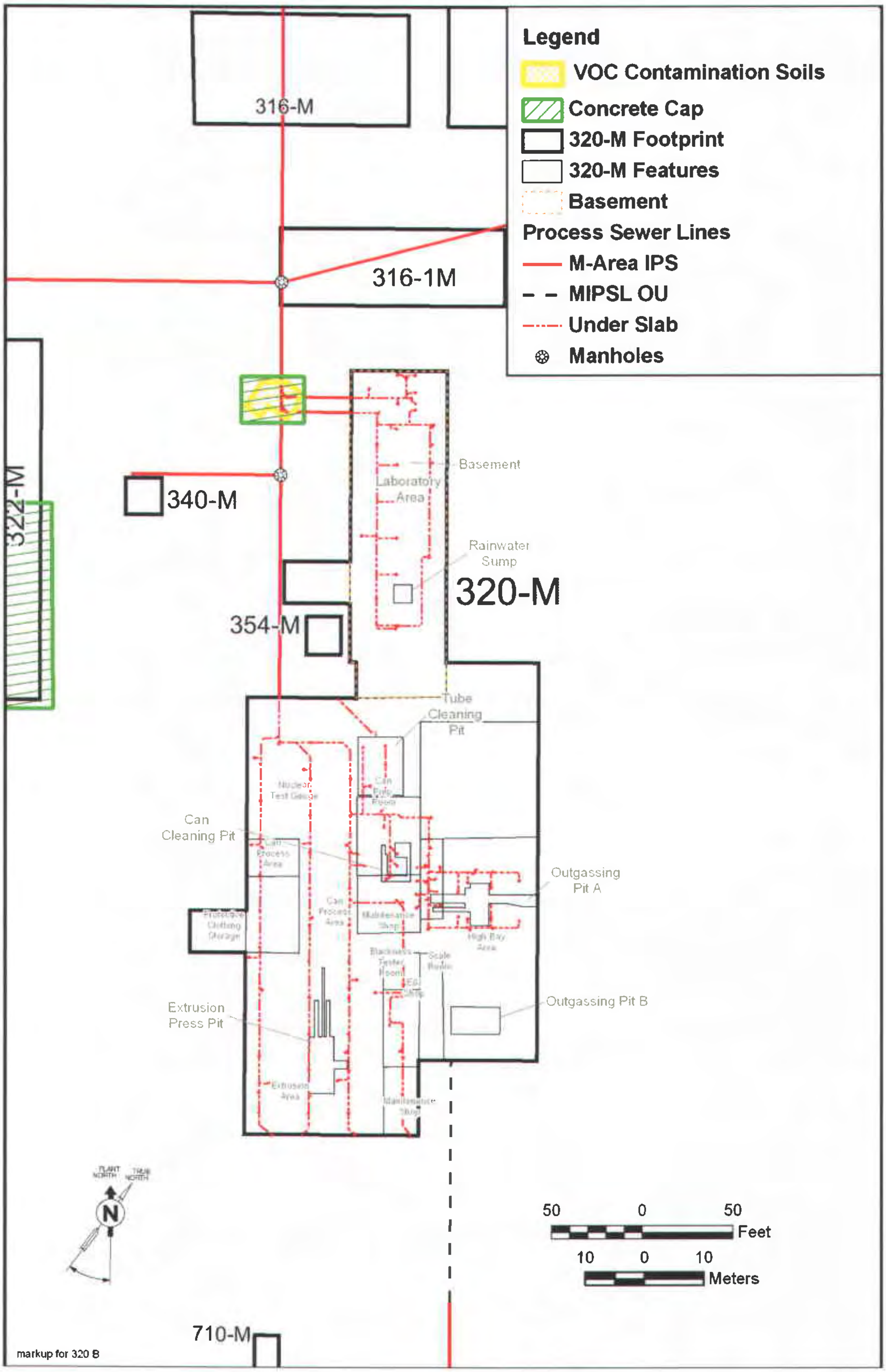



**Figure 16.** **Building 320-M, Alternative A-3**

| Activity ID | Activity Description | Orig Dur | Early Start | Early Finish |
|---|---|---|---|---|
| **M AREA OPERABLE UNIT** | | | | |
| **LCS 14 - REGULATORY REQUIREMENTS** | | | | |
| **SB/PP Scoping Summary** | | | | |
| RMP0608200 | Develop SB/PP Scoping Package | 38 | 24MAY07A | 18JUL07A |
| RMP0608250 | Submit SB/PP Scoping Package | 0 | | 18JUL07A |
| RMP0608400 | SP/PP Scoping Meeting | 0 | | 01AUG07A |
| **Proposed Plan** | | | | |
| RMP0608350 | SRS - Develop Rev. 0 SB/PP | 49 | 19JUL07A | 26SEP07A |
| RMP0608500 | SRS - Submit Rev. 0 SB/PP | 0 | | 26SEP07A |
| RMP0608550 | EPA/DHEC review Rev. 0 SB/PP | 61 | 27SEP07A | 16NOV07A |
| RMP0608600 | EPA/DHEC return Rev. 0 SB/PP comments | 0 | | 16NOV07A |
| RMP0608650 | SRS - Incorporate EPA/DHEC SB/PP comments | 88 | 19NOV07A | 14FEB08A |
| RMP0608625 | SB/PP Comment Resolution Meeting | 0 | 12DEC07A | |
| RMP0608850 | SRS - Submit Redline Rev. 1 SB/PP | 0 | | 14FEB08A |
| RMP0608900 | EPA/DHEC Issue Comments on Redline SB/PP | 32 | 15FEB08A | 14MAR08A |
| RMP0608910 | SRS Develop/Submit Change-Out pages | 12 | 17MAR08A | 27MAR08A |
| RMP0608930 | Submit Redline Rev 1 SB/PP to EPA/DHEC | 0 | | 27MAR08A |
| RMP0608940 | EPA/DHEC Approval of Redline Rev 1 SP/PP | 17* | 28MAR08A | 28APR08 |
| RMP0608920 | Rev. 1 Redline Comment Resolution Meeting | 1 | 02APR08A | 02APR08A |
| RMP0608950 | Notification of Public Comment Period | 14 | 29APR08 | 12MAY08 |
| RMP0609000 | SRS - Transmit Certified Clean Copy of SB/PP | 30 | 29APR08 | 28MAY08 |
| RMP0609050 | Public Comment Period | 45 | 13MAY08 | 26JUN08 |
| **Record of Decision** | | | | |
| RMP0608700 | Develop ROD Rev. 0 | 99* | 21FEB08A | 11JUL08 |
| RMP0608702 | Responsiveness Summary and Approvals | 14 | 27JUN08 | 11JUL08 |
| RMP0609150 | SRS - Submit Rev. 0 ROD | 0 | | 11JUL08 |
| RMP0609200 | EPA/DHEC review Rev. 0 ROD | 60 | 12JUL08 | 10SEP08 |
| RMP0609250 | EPA/DHEC return Rev. 0 ROD comments | 0 | | 10SEP08 |
| RMP0609300 | SRS - Incorporate EPA/DHEC ROD comments | 61 | 11SEP08 | 10NOV08 |
| RMP0609400 | SRS - Submit Redline Rev.1 ROD | 0 | | 10NOV08 |
| RMP0609450 | EPA/DHEC Final Review/Approval ROD | 30 | 12NOV08 | 11DEC08 |
| RMP0609500 | Receipt of ROD Approval | 0 | | 11DEC08 |
| RMP0609550 | DOE obtain signature on ROD | 30 | 12DEC08 | 13JAN09 |
| RMP0609600 | EPA Obtain Signature on ROD | 30 | 14JAN09 | 12FEB09 |
| RMP0609650 | DHEC obtain signature on ROD | 31 | 13FEB09 | 16MAR09 |
| RMP0609700 | Prepare for Public Notice | 14 | 17MAR09 | 30MAR09 |
| RMP0609750 | Issue M Area OU ROD | 0 | | 30MAR09 |

FY07 FY08 FY09
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S

| | |
|---|---|
| Start Date | 20JAN04 |
| Finish Date | 29OCT10 |
| Data Date | 09APR08 |
| Run Date | 16APR08 09:08 |

Early Bar
Progress Bar

MAE2 Sheet 1 of 2

M AREA OPERABLE UNIT
Implementation Schedule

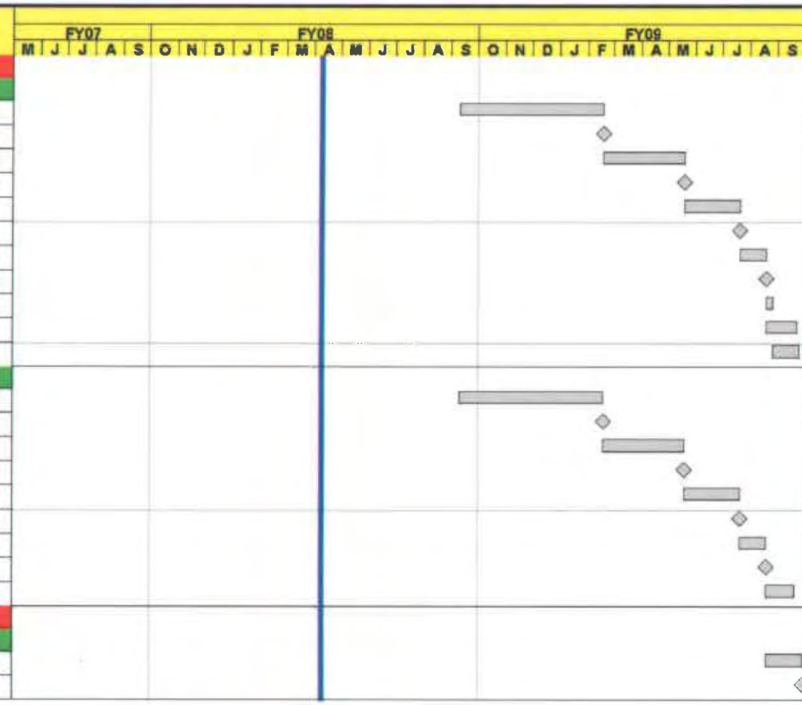
S&G SOIL AND GROUNDWATER CLOSURE PROJECTS

| Date | Revision | Checked | Approved |
|---|---|---|---|



**Figure 17. Post-ROD Implementation Schedule**

| Activity ID | Activity Description | Orig Dur | Early Start | Early Finish |
|---|---|---|---|---|
| LCS 15 - DETAILED ENG & PRECONST ACTIVITIES | | | | |
| CMI/RAIP | | | | |
| RMP0609850 | Develop Rev. 0 CMI/RAIP | 108 | 11SEP08 | 17FEB09 |
| RMP0610050 | SRS - Submit Rev. 0 CMI/RAIP | 0 | | 17FEB09 |
| RMP0610100 | EPA/DHEC Review Rev. 0 CMI/RAIP | 90 | 18FEB09 | 19MAY09 |
| RMP0610300 | EPA/DHEC Return Rev. 0 CMI/RAIP Comments | 0 | | 19MAY09 |
| RMP0610350 | SRS - Incorporate EPA/DHEC CMI/RAIP Comments | 62 | 20MAY09 | 20JUL09 |
| RMP0610450 | SRS - Submit Redline Rev.1 CMI/RAIP | 0 | | 20JUL09 |
| RMP0610500 | EPA/DHEC Final Rev/Approval CMI/RAIP | 30 | 21JUL09 | 19AUG09 |
| RMP0610502 | Receive EPA/DHEC Approval CMI/RAIP | 0 | | 19AUG09 |
| RMP0610506 | Notification of Pre-Constr. Briefing Fact Sheet | 7 | 20AUG09 | 26AUG09 |
| RMP0610504 | SRS - Transmit Certified Clean Copy of CMI/RAIP | 32 | 20AUG09 | 21SEP09 |
| RMP0610508 | Pre-Construction Briefing Fact Sheet Public Rev. | 30 | 27AUG09 | 25SEP09 |
| LUCIP | | | | |
| RMP0610510 | Develop Rev. 0 LUCIP | 108 | 11SEP08 | 17FEB09 |
| RMP0610514 | SRS - Submit Rev. 0 LUCIP | 0 | | 17FEB09 |
| RMP0610516 | EPA/DHEC review Rev. 0 LUCIP | 90 | 18FEB09 | 19MAY09 |
| RMP0610518 | EPA/DHEC Return Rev. 0 LUCIP Comments | 0 | | 19MAY09 |
| RMP0610520 | SRS - Incorporate EPA/DHEC LUCIP Comments | 62 | 20MAY09 | 20JUL09 |
| RMP0610524 | SRS - Submit Redline Rev.1 LUCIP | 0 | | 20JUL09 |
| RMP0610526 | EPA/DHEC Final Rev/Approval LUCIP | 30 | 21JUL09 | 19AUG09 |
| RMP0610528 | Received EPA/DHEC Approval LUCIP | 0 | | 19AUG09 |
| RMP0610530 | SRS - Transmit Clean Copy of LUCIP | 30 | 20AUG09 | 19SEP09 |
| LCS 16 - CONSTRUCTION | | | | |
| Final Action Construction | | | | |
| RMP0610750 | Mobilization | 40 | 20AUG09 | 29SEP09 |
| RMP0610800 | Final Remedial Action Start | 0 | 30SEP09 | |




Sheet 2 of 2

**Figure 17. Post-ROD Implementation Schedule *(Continued/End)***

# *TABLES*

**Table 1. Summary of Refined Constituents of Concern**

| | | Pre-Early Action | | | Post-Early Action | | |
|---|---|---|---|---|---|---|---|
| **Subunit/Facility** | **ARAR* RCOCs** | **CM RCOCs** | **HH RCOCs** | **PTSM RCOCs** | **CM RCOCs** | **HH RCOCs** | **PTSM RCOCs** |
| **Production Area** | | | | | | | |
| 313-M Slug Production Facility | none | *concrete*<br>PCE<br>*soil*<br>PCE | *concrete surface*<br>U-235 (+D)<br>U-238 (+D) | *concrete*<br>U-238 (+D)<br>Uranium (metal) | *soil*<br>PCE<br>Core Cleaning Solvent Tank Pit | *concrete surface*<br>U-235 (+D) <0.6 pCi/g<br>U-238 (+D) <10.0 pCi/g<br>Sporadic Contamination on concrete surface | none |
| 321-M Fuel Fabrication Facility | none | *concrete*<br>PCE, TCE<br>*soil*<br>PCE, TCE | *concrete surface*<br>U-235 (+D) | *concrete*<br>U-235 (+D)<br>*soil*<br>PCE | *soil*<br>PCE and TCE under Tube Cleaning Pit and at MIPSL tie-in, PCE at Manhole 4A | none | *soil*<br>PCE<br>Under the Cleaning Pit |
| 320-M Alloy Building | none | *soil* MIPSL tie–in - TCE<br>Tube Cleaning Pit - PCE | none | none | Minor TCE at MIPSL Tie-in | none | none |
| 322-M Metallurgical Laboratory | none | *soil*<br>PCE at Manhole 6A | *concrete surface*<br>U-235 (+D)<br>U-238 (+D) | *concrete*<br>U-235 (+D)<br>Ra-226 (+D)<br>K-40<br>*sludge (in pipes)*<br>U-235 (+D)<br>U-238 (+D) | none | *concrete surface*<br>U-235 (+D) <0.6 pCi/g<br>U-238 (+D)<br>10.0 pCi/g Sporadic contamination on concrete surface | none |
| 340-M Filter Press Bldg. | none | none | none | none | none | none | none |
| 324-M Vertical Press Bldg. | none | none | none | none | none | none | none |
| **Liquid Effluent Treatment Facilities** | | | | | | | |
| 341-M Dilute Effluent Treatment Facility | none | none | none | none | none | none | none |
| 341-1M Interim Treatment Storage Facility | none | none | *concrete surface*<br>U-235 (+D)<br>U-238 (+D) | none | none | *concrete surface*<br>U-235 (+D) <0.6 pCi/g<br>U-238 (+D) <10.0 pCi/g Minor contamination on wall | none |

**Table 1. Summary of Refined Constituents of Concern *(Continued/End)***

| | | Pre-Early Action | | | Post-Early Action | | |
|---|---|---|---|---|---|---|---|
| **Subunit/Facility** | **ARAR* RCOCs** | **CM RCOCs** | **HH RCOCs** | **PTSM RCOCs** | **CM RCOCs** | **HH RCOCs** | **PTSM RCOCs** |
| 341-8M Vendor Treatment Facility | none | none | *concrete surface*<br>U-235 (+D)<br>U-238 (+D) | none | none | *concrete surface*<br>U-235 (+D)<br><0.6 pCi/g<br>U-238 (+D)<br><10.0 pCi/g<br>Sporadic contamination on concrete surface | none |
| **Test Reactors** | | | | | | | |
| 305-A Test Pile Facility | none | none | none | none | none | none | none |
| 777-10-A Site Utilities Office Building (Physics Laboratory) | none | none | none | none | none | none | none |
| **Salvage Area** | | | | | | | |
| 740-A Reclamation Bldg. | none | none | none | none | none | none | none |
| 741-A Salvage Yard | none | none | *surface soil/gravel*<br>As<br>Aroclor® 1254<br>Aroclor® 1260<br>Benzo(a)anthracene<br>Benzo(a)pyrene<br>Benzo(b)-fluoranthene | none | none | none | none |
| 743-A Rigging Storage Facility | none | none | none | none | none | none | none |

*ARAR – Applicable or relevant and appropriate requirements

**Table 2. Summary of Results of the Human Health Risk Assessment**

| | Pre-Early Action | | | Post-Early Action | | | |
|---|---|---|---|---|---|---|---|
| **Subunit/Facility** | **HH RCOCs** | **Industrial Worker Risk Estimate** | **Total Cumulative Risk** | **HH RCOCs** | **Industrial Worker Risk Estimate** | **Total Cumulative Risk** | **Media** |
| **Production Area** | | | | | | | |
| 313-M Slug Production Facility | U-235 (+D)<br>U-238 (+D) | 1.1E-05<br>8.5E-05 | 9.6E-05 | *concrete surface*<br>U-235 (+D)<br><0.6 pCi/g<br>U-238 (+D)<br><10.0 pCi/g<br>Sporadic contamination on concrete surface | 1.5E-06<br>5.3E-06 | 7E-06 | concrete slab surface |
| 321-M Fuel Fabrication Facility | U-235 (+D) | 8.6E-05 | 8.6E-05 | none | not applicable | not applicable | concrete slab surface |
| 320-M Alloy Building | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| 322-M Metallurgical Laboratory | U-235 (+D)<br>U-238 (+D) | 1.8E-05<br>1.2E-05 | 3.0E-05 | *concrete surface*<br>U-235 (+D)<br><0.6 pCi/g<br>U-238 (+D)<br><10.0 pCi/g<br>Sporadic contamination on concrete surface | 1.5E-06<br>5.3E-06 | 7E-06 | concrete slab surface |
| 340-M Filter Press Building | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| 324-M Vertical Press Building | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| **Liquid Effluent Treatment Facilities** | | | | | | | |
| 341-M Dilute Effluent Treatment Facility | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| 341-1M Interim Treatment Storage Facility | U-235 (+D)<br>U-238 (+D) | 5.3E-06<br>1.0E-05 | 1.5E-05 | *concrete surface*<br>U-235 (+D)<br><0.6 pCi/g<br>U-238 (+D)<br><10.0 pCi/g Minor contamination on wall | 1.5E-06<br>5.3E-06 | 7E-06 | concrete wall surface |

Table 2. **Summary of Results of the Human Health Risk Assessment** *(End)*

| | Pre-Early Action | | | Post-Early Action | | | |
|---|---|---|---|---|---|---|---|
| **Subunit/Facility** | **HH RCOCs** | **Industrial Worker Risk Estimate** | **Total Cumulative Risk** | **HH RCOCs** | **Industrial Worker Risk Estimate** | **Total Cumulative Risk** | **Media** |
| **Liquid Effluent Treatment Facilities** *(Continued)* | | | | | | | |
| 341-8M Vendor Treatment Facility | U-235 (+D)<br>U-238 (+D) | 8.3E-06<br>5.1E-05 | 5.9E-05 | *concrete surface*<br>U-235 (+D) <0.6 pCi/g<br>U-238 (+D) <10.0 pCi/g<br>Minor contamination on slab | 1.5E-06<br>5.3E-06 | 7E-06 | concrete slab surface |
| **Test Reactors** | | | | | | | |
| 305-A Test Pile Facility | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| 777-10-A Site Utilities Office Building (Physics Laboratory) | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| **Salvage Area** | | | | | | | |
| 740-A Reclamation Building | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |
| 741-A Salvage Yard | As<br>Aroclor® 1254<br>Aroclor® 1260<br>Benzo(a)anthracene<br>Benzo(a)pyrene<br>Benzo(b)-fluoranthene | 1.4E-05<br>3.7E-06<br>1.4E-06<br>1.6E-06<br>1.6E-05<br>2.9E-06 | 4.0E-05 | none | not applicable | not applicable | surface soil/gravel |
| 743-A Rigging Storage Facility | none | not applicable | not applicable | none | not applicable | not applicable | not applicable |

U-235 = uranium 235; U-238 = uranium-238; As = arsenic

**Table 3. Summary of Results of the PTSM Evaluation**

| | Pre-Early Action | | Post-Early Action | | |
|---|---|---|---|---|---|
| Subunit/Facility | PTSM RCOCs | Risk Estimate | PTSM RCOCs | Risk Estimate | Media |
| **Production Area** | | | | | |
| 313-M Slug Production Facility | U-238 (+D)<br>Uranium (metal) | 2.2E-03<br>HQ = 13.2 | none | not applicable | concrete<br>concrete |
| 321-M Fuel Fabrication Facility | U-235 (+D)<br>PCE | 1.7E-03<br>9.4E-03 | none | not applicable | concrete<br>soil |
| 320-M Alloy Building | none | not applicable | none | not applicable | not applicable |
| 322-M Metallurgical Laboratory | U-238 (+D)<br>Ra-226 (+D)<br>K-40<br>U-235 (+D)<br>U-238 (+D) | 1.3E-03<br>1.7E-03<br>1.2E-03<br>1.8E-03<br>1.7E-02 | none | not applicable | concrete<br>concrete<br>concrete<br>sludge<br>sludge |
| 340-M Filter Press Building | none | not applicable | none | not applicable | not applicable |
| 324-M Vertical Press Building | none | not applicable | none | not applicable | not applicable |
| **Liquid Effluent Treatment Facilities** | | | | | |
| 341-M Dilute Effluent Treatment Facility | none | not applicable | none | not applicable | not applicable |
| 341-1M Interim Treatment Storage Facility | none | not applicable | none | not applicable | not applicable |
| 341-8M Vendor Treatment Facility | none | not applicable | none | not applicable | not applicable |
| **Test Reactors** | | | | | |
| 305-A Test Pile Facility | none | not applicable | none | not applicable | not applicable |
| 777-10-A Site Utilities Office Building (Physics Laboratory) | none | not applicable | none | not applicable | not applicable |
| **Salvage Area** | | | | | |
| 740-A Reclamation Building | none | not applicable | none | not applicable | not applicable |
| 741-A Salvage Yard | none | not applicable | none | not applicable | not applicable |
| 743-A Rigging Storage Facility | none | not applicable | none | not applicable | not applicable |

U-235 = uranium 235; U-238 = uranium-238; Ra = Radium 226; K-40 = Potassium 40

**Table 4. Summary of Results of the Contaminant Migration Analysis**

| Subunit/Facility | CM RCOCs | |
|---|---|---|
| **Production Area** | **Pre-Early Action** | **Post-Early Action** |
| 313-M Slug Production Facility | *concrete*<br>PCE<br>*soil*<br>PCE | *soil*<br>PCE<br>Solvent Tank Pit |
| 321-M Fuel Fabrication Facility | *concrete*<br>PCE<br>*soil*<br>PCE, TCE | *soil*<br>PCE, TCE<br>under Tube Cleaning Room and at MIPSL tie-in<br>Minor PCE at Manhole 4A |
| 320-M Alloy Building | *soil*: MIPSL tie–in - TCE<br>Tube Cleaning Pit - PCE | *soil*<br>Minor TCE at MIPSL Tie-in |
| 322-M Metallurgical Laboratory | *soil*<br>PCE | *none* |
| 340-M Filter Press Building | none | *none* |
| 324-M Vertical Press Building | none | *none* |
| **Liquid Effluent Treatment Facilities** | | |
| 341-M Dilute Effluent Treatment Facility | none | *none* |
| 341-1M Interim Treatment Storage Facility | none | *none* |
| 341-8M Vendor Treatment Facility | none | *none* |
| **Test Reactors** | | |
| 305-A Test Pile Facility | none | *none* |
| 777-10-A Site Utilities Office Building (Physics Laboratory) | none | *none* |
| **Salvage Area** | | |
| 740-A Reclamation Building | none | *none* |
| 741-A Salvage Yard | none | *none* |
| 743-A Rigging Storage Facility | none | *none* |

*CM RCOCs – Contaminant Migration Refined Constituents of Concern

**Table 5. Summary of Post Early Actions RGOs for MAOU**

| RCOC | Units | CM[1] | HH[2] | Most Restrictive RGO[3] | SRS 95th Percentile Background[4] | Most Likely RGO[5] |
|---|---|---|---|---|---|---|
| **SOIL MEDIA** | | | | | | |
| ***Organics*** | | | | | | |
| Tetrachloroethylene (PCE) | mg/kg | 1.80[6]<br>2.80[7]<br>3.00[9] | NA | 1.80[6]<br>2.80[7]<br>3.00[9] | NA | 1.80[6]<br>2.80[7]<br>3.00[9] |
| Trichloroethylene (TCE) | mg/kg | 15.00[8] | NA | 15.00[8] | NA | 15.00[8] |
| **CONCRETE MEDIA** | | | | | | |
| ***Radionuclides*** | | | | | | |
| Uranium-235 (+D) | pCi/g | NA | 0.402 | 0.402 | 0.11 | 0.402 |
| Uranium-238 (+D) | pCi/g | NA | 1.90 | 1.90 | 1.20 | 1.90 |

1. The CM RGO is the soil concentration that is not predicted to impact groundwater above MCLs based on the waste unit configuration after early actions.
2. The HH RGO is the contaminant concentration in concrete equal to a risk of 1E-06 for a future industrial worker.
3. The most restrictive RGO is the lower of the CM RGO and HH RGO.
4. SRS sitewide background value is 95th percentile for soil from *the 2006 Background Soils Statistical Summary Report,* Appendix B-2 (WSRC 2006c).
5. The most likely RGO is the most restrictive RGO concentration, if it is greater than the SRS sitewide background concentration. If the most restrictive RGO concentration is less than the SRS background concentration, then the RGO defaults to the background value.
6. RGOs for Building 313-M.
7. RGOs for Building 320-M Tubing Cleaning Pit.
8. RGOs for Building 320-M MIPSL Tie-in
9. RGOs for Building 321-M

NA - not applicable (no RCOCs)

**Table 6. Summary of Potential ARARs for the MAOU**

| Citation | Status | Requirement Summary | Reason for Inclusion |
|---|---|---|---|
| **Chemical-specific ARARs** | | | |
| 40 CFR 122 National Pollutant Discharge Elimination System (NPDES) or Water Pollution Control Permits SC R.61-9 | Applicable | Regulates discharges of pollutants from any point source into waters of the US and SC | Applicable if water from the MAOU will be discharged to land or streams, rivers or lakes |
| 40 CFR 141 National Primary Drinking Water Regulations | Applicable | Standards for maintaining water quality | Generally applicable for maintaining groundwater quality |
| 40 CFR 268 Land Disposal Regulations | Applicable | Identifies land disposal restrictions and specifies treatment standards for specified waste. | Applicable if water is discharged to land. Also movement of excavated material outside the site may trigger land disposal restrictions. |
| **Action-specific ARARs** | | | |
| 40 CFR 50.6 National Primary and Secondary Ambient Air Quality Standards | Applicable | Regulates concentration of particulate matter in ambient air not to exceed 50 µg/m3 (annual arithmetic mean) or 150 µg/m3 (24-hour average concentration) | Dust suppression likely required to minimize dust emissions during construction/remedial action. |
| SC R.61-62.6 Control of Fugitive or Particulate Matter | Applicable | Regulates fugitive particulate emissions | Dust suppression likely required to minimize dust emissions during construction/remedial action. |
| SC R72-300 and 400 Standards for Stormwater Management and Sediment Reduction | Applicable | Regulates stormwater management and sediment control during land disturbing activities. Also discusses erosion and runoff control measures. | Land will be disturbed during construction/remedial actions and runoff and erosion may be applicable to the remedial responses. Remedial activities may require an erosion control plan. |
| 40 CFR 257-258 Disposal of Nonhazardous Waste | Applicable | Governs the management of (sanitary and construction/ demolition) non-hazardous waste | Sanitary waste may be produced from remedial actions |
| 40 CFR 260, 261, 262, 264, and 268 SC R.79.260, 261 and 268 Federal and State Hazardous Waste Regulations | Applicable | Defines criteria for determining whether a waste is RCRA hazardous waste and provides treatment, storage, and disposal requirements. | Would be applicable if hazardous waste is found to be present at the MAOU and removed from area of contamination. |
| SC R.61-62.5 Standard 8 | Applicable | Toxic Air Pollutants. Identifies air concentrations and permit requirements for air emissions of toxic chemicals for new and existing sources | Would be applicable if soil vapor extraction (SVE) is used as a remedial action |
| SC R61-58.1 and 58.2 Construction and Operations Permits – Groundwater Sources and Treatment | Applicable | Prescribes minimum standards for the construction of groundwater sources and treatment facilities | Would be applicable to well construction and remediation |
| SC R61-87 Underground Injection Control Regulations | Applicable | Specific requirements for controlling underground injections | May be applicable if underground injection is utilized as remedial action |
| **Location-specific ARARs** | | | |
| 16 USC 703 to 712 Migratory Bird Treaty Act | To Be Considered | The remedial action must be conducted in a manner that minimizes effects on migratory birds and their habitats. | Migratory bird populations may be present in the vicinity of the MAOU. |

**Table 7. Comparative Analysis Summary for the MAOU Building 313-M**

| Criterion | Alternative A-1 | Alternative A-4 | Alternative A-3 |
|---|---|---|---|
| | No Action | Passive Soil Vapor Extraction (SVE), Institutional Controls | Concrete Cap, Institutional Control |
| **Overall Protection of Human Health and the Environment** | | | |
| Protection of Human Health | Not Protective | Protective; reduces future resident exposure to contaminants. | Protective; Provides a barrier to prevent human exposure |
| Protection of the Environment | Not Protective | Protective; Protects by treatment of VOCs to prevent contaminant migration | Protective; Protects groundwater with an infiltration control barrier |
| Effectiveness in Meeting Remediation Goal | Not Effective | Effective; Treatment reduces VOCs to achieve RGOs | Effective; Barrier technology not very effective in reducing VOCs to achieve RGOs |
| **Compliance with ARARs** | | | |
| Chemical-Specific | No action taken to meet chemical ARARs | Complies with protection of groundwater | Complies with protection of groundwater |
| Location-Specific | Not Applicable | Protective for migratory birds | Protective for migratory birds |
| Action-Specific | Not Applicable | Complies with land disturbance requirements, air emission requirements, and hazardous waste management | Complies with land disturbance requirements |
| **Long-Term Effectiveness and Permanence** | | | |
| Magnitude of Residual Risks | Risk not reduced; vadose zone COC still pose risk to groundwater quality | Risks are reduced to acceptable levels by preventing impact to groundwater | Risks are reduced to acceptable levels by controlling exposure pathway and preventing impact to groundwater |
| Adequacy of Controls | Not Adequate | Adequate | Adequate |
| Permanence | Not Permanent | Permanent | Permanent |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | |
| Treatment Process | None | Passive SVE removes VOCs | Not applicable |
| Degree of Expected Reduction in Toxicity, Mobility, or Volume | None | High - Contaminant mobility is reduced by treatment | Mobility is decreased with use of a barrier system |
| Amount of Hazardous Materials Destroyed or Treated | None | Would substantially reduce amount of VOCs in vadose zone | Hazardous materials are not destroyed or treated |
| Degree to Which Treatment is Irreversible | No treatment | Irreversible | Reversible |
| Types and Quantities of Residuals Remaining after Treatment | None | No residuals | VOC residuals remain |
| **Short-Term Effectiveness** | | | |
| Risk to Remedial Workers | None | Minimal; limited land disturbance activities | Minimal; limited land disturbance activities |
| Risk to Community | None | None | None |
| Risks to Environment | None | Negligible | Negligible |
| Estimated Time Frame to Achieve RAOs | Not achieved | 10 years | 10 years |
| **Implementability** | | | |
| Availability of Materials, Equipment, and Skilled Labor | Not Applicable | Straightforward; materials, equipment, and labor are readily available | Straightforward; materials, equipment, and labor are readily available |
| Ability to Construct and Operate the Remedial Technology | Not Applicable | Readily implemented. | Readily implemented. |
| Ability to Obtain Permits/Approvals from Agencies | Readily implemented | Permits readily obtained | Permits readily obtained |
| Ability to Monitor Effectiveness of Remedy | Not Applicable | Readily monitored through vacuum and flow measurements and sampling | Readily monitored through inspections and groundwater sampling |
| Ease of Undertaking Additional Actions | Compatible | May not be compatible with simultaneous implementation of other actions | May not be compatible with simultaneous implementation of other actions |
| Time to Implement | 0 months | 4 months | 3 months |
| **Cost** | | | |
| **Total Estimated Capital Cost** | **$0** | **$119,635** | **$316,899** |
| **Total Estimated Present Worth O&M Cost** | **$0** | **$219,369** | **$235,255** |
| **Total Present-Worth Costs** | **$0** | **$339,005** | **$552,154** |

**Table 8. Comparative Analysis Summary for the MAOU Building 321-M**

| Criterion | Alternative A-1 | Alternative A-4 | Alternative A-3 |
|---|---|---|---|
| | No Action | Passive Soil Vapor Extraction (SVE), Institutional Controls | Concrete Cap, Institutional Controls |
| **Overall Protection of Human Health and the Environment** | | | |
| Protection of Human Health | Not Protective | Protective; Reduces contaminant impact to groundwater by treatment | Protective; Reduces contaminant impact to groundwater with a barrier |
| Protection of the Environment | Not Protective | Protective; Protects groundwater by depleting contaminant sources | Protective; Protects groundwater by providing a barrier to contaminant sources |
| Effectiveness in Meeting Remediation Goal | Not Effective | Effective; treatment reduces VOCs to achieve RGOs | Not very effective in reducing VOCs to achieve RGOs |
| **Compliance with ARARs** | | | |
| Chemical-Specific | No action taken to meet chemical ARARs | Complies with protection of groundwater | Complies with protection of groundwater |
| Location-Specific | Not Applicable | Protective for migratory birds | Protective for migratory birds |
| Action-Specific | Not Applicable | Complies with air emission requirements, fugitive dust requirements, and hazardous waste management | Complies with dust suppression management |
| **Long-Term Effectiveness and Permanence** | | | |
| Magnitude of Residual Risks | Risk not reduced; vadose zone COC still pose risk to groundwater quality | Risks are reduced to acceptable levels by extracting VOCs and preventing impact to groundwater | Risks are reduced to acceptable levels by controlling exposure pathway and preventing impact to groundwater |
| Adequacy of Controls | Not Adequate | Adequate | Adequate |
| Permanence | Not Permanent | Permanent | Permanent |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | |
| Treatment Process | None | Passive SVE for VOC removal | Barrier technology prevents migration of VOCs |
| Degree of Expected Reduction in Toxicity, Mobility, or Volume | None | High - Contaminant mobility is reduced by treatment | High-Contaminant mobility is reduced by a barrier |
| Amount of Hazardous Materials Destroyed or Treated | None | Would substantially reduce amount of VOCs in vadose zone | Would not substantially reduce amount of VOCs in vadose zone |
| Degree to Which Treatment is Irreversible | No treatment | Irreversible | Reversible |
| Types and Quantities of Residuals Remaining after Treatment | None | Minimal VOC residuals | VOC residuals would remain under the cover system |
| **Short-Term Effectiveness** | | | |
| Risk to Remedial Workers | None | Minimal; limited land disturbance activities | Minimal; limited land disturbance activities |
| Risk to Community | None | None | None |
| Risks to Environment | None | Negligible | Negligible |
| Estimated Time Frame to Achieve RAOs | Not achieved | 10 years | 10 years |
| **Implementability** | | | |
| Availability of Materials, Equipment, and Skilled Labor | Not Applicable | Straightforward; materials, equipment, and labor are readily obtainable | Straightforward; materials, equipment, and labor are readily obtainable |
| Ability to Construct and Operate the Remedial Technology | Not Applicable | Readily implemented. | Readily implemented. |
| Ability to Obtain Permits/Approvals from Agencies | Readily implemented | Permits readily obtained | Permits readily obtained |
| Ability to Monitor Effectiveness of Remedy | Not Applicable | Readily monitored through vacuum and flow measurements and sampling | Readily monitored through sampling |
| Ease of Undertaking Additional Actions | Compatible | May not be compatible with simultaneous implementation of other actions | May not be compatible with simultaneous implementation of other actions |
| Time to Implement | 0 months | 4 months | 3 |
| **Cost** | | | |
| **Total Estimated Capital Cost** | **$0** | **$932,938** | **$547,074** |
| **Total Estimated Present Worth O&M Cost** | **$0** | **$350,136** | **$235,255** |
| **Total Present-Worth Costs** | **$0** | **$1,283,074** | **$782,329** |

**Table 9. Comparative Analysis Summary for the MAOU Building 320-M**

| Criterion | Alternative A-1 | Alternative A-4 | Alternative A-3 |
|---|---|---|---|
| | No Action | Passive Soil Vapor Extraction (SVE), at MIPSL Tie-In, Institutional Controls | Concrete Cap, Institutional Controls |
| **Overall Protection of Human Health and the Environment** | | | |
| Protection of Human Health | Not Protective | Protective; Reduces contaminant impact to groundwater by treatment | Protective; Reduces contaminant impact to groundwater with a barrier |
| Protection of the Environment | Not Protective | Protective; Protects groundwater by depleting contaminant sources | Protective; Protects groundwater by providing a barrier to contaminant sources |
| Effectiveness in Meeting Remediation Goal | Not Effective | Effective; treatment reduces VOCs to achieve RGOs | Not very effective in reducing VOCs to achieve RGOs |
| **Compliance with ARARs** | | | |
| Chemical-Specific | No action taken to meet chemical ARARs | Complies with protection of groundwater | Complies with protection of groundwater |
| Location-Specific | Not Applicable | Protective for migratory birds | Protective for migratory birds |
| Action-Specific | Not Applicable | Complies with air emission requirements, fugitive dust requirements, and hazardous waste management | Complies with dust suppression management |
| **Long-Term Effectiveness and Permanence** | | | |
| Magnitude of Residual Risks | Risk not reduced; vadose zone COC still pose risk to groundwater quality | Risks are reduced to acceptable levels by extracting VOCs and preventing impact to groundwater | Risks are reduced to acceptable levels by controlling exposure pathway and preventing impact to groundwater |
| Adequacy of Controls | Not Adequate | Adequate | Adequate |
| Permanence | Not Permanent | Permanent | Permanent |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | |
| Treatment Process | None | Passive SVE for VOC removal | Barrier technology prevents migration of VOCs |
| Degree of Expected Reduction in Toxicity, Mobility, or Volume | None | High - Contaminant mobility is reduced by treatment | High-Contaminant mobility is reduced by a barrier |
| Amount of Hazardous Materials Destroyed or Treated | None | Would substantially reduce amount of VOCs in vadose zone | Would not substantially reduce amount of VOCs in vadose zone |
| Degree to Which Treatment is Irreversible | No treatment | Irreversible | Reversible |
| Types and Quantities of Residuals Remaining after Treatment | None | Minimal VOC residuals | VOC residuals would remain under the cover system |
| **Short-Term Effectiveness** | | | |
| Risk to Remedial Workers | None | Controlled through Work Plan | Minimal; limited land disturbance activities |
| Risk to Community | None | None | None |
| Risks to Environment | None | Negligible | Negligible |
| Estimated Time Frame to Achieve RAOs | Not achieved | 10 years | 10 years |
| **Implementability** | | | |
| Availability of Materials, Equipment, and Skilled Labor | Not Applicable | Straightforward; materials, equipment, and labor are readily obtainable | Straightforward; materials, equipment, and labor are readily obtainable |
| Ability to Construct and Operate the Remedial Technology | Not Applicable | Readily implemented. | Readily implemented. |
| Ability to Obtain Permits/Approvals from Agencies | Readily implemented | Permits readily obtained | Permits readily obtained |
| Ability to Monitor Effectiveness of Remedy | Not Applicable | Readily monitored through vacuum and flow measurements and sampling | Readily monitored through sampling |
| Ease of Undertaking Additional Actions | Compatible | May not be compatible with simultaneous implementation of other actions | May not be compatible with simultaneous implementation of other actions |
| Time to Implement | 0 months | 4 months | 3 months |
| **Cost** | | | |
| **Total Estimated Capital Cost** | **$0** | **$110,484** | **$345,946** |
| **Total Estimated Present Worth O&M Cost** | **$0** | **$350,136** | **$235,255** |
| **Total Present-Worth Costs** | **$0** | **$460,620** | **$581,201** |

Table 10. Comparative Analysis Summary for the MAOU Buildings 322-M, 341-M, 341-1M, 341-8M, 340-M, 324-M, 741-A, 740-A, and 743-A, 305-A, 777-10A

| Criterion | Alternative 1 | Alternative 2 |
|---|---|---|
| | No Action | Institutional Controls |
| **Overall Protection of Human Health and the Environment** | | |
| Protection of Human Health | Not Protective | Protective; Reduces future resident exposure to contaminants |
| Protection of the Environment | Not Protective | Protective; Limits access and work performed in the area |
| Effectiveness in Meeting Remediation Goal | Not Effective | Not Applicable |
| **Compliance with ARARs** | | |
| Chemical-Specific | No action taken to meet chemical ARARs | Not Applicable |
| Location-Specific | Not Applicable | Not Applicable |
| Action-Specific | Not Applicable | Not Applicable |
| **Long-Term Effectiveness and Permanence** | | |
| Magnitude of Residual Risks | Minimal radionuclide and VOC risks remain | Minimal Risks remain but are controlled to limit access and prevent exposure |
| Adequacy of Controls | Not Adequate | Adequate |
| Permanence | Not Permanent | Permanent |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | |
| Treatment Process | None | None |
| Degree of Expected Reduction in Toxicity, Mobility, or Volume | None | Not Applicable |
| Amount of Hazardous Materials Destroyed or Treated | None | Not Applicable |
| Degree to Which Treatment is Irreversible | No treatment | Not Applicable |
| Types and Quantities of Residuals Remaining after Treatment | None | No residuals |
| **Short-Term Effectiveness** | | |
| Risk to Remedial Workers | None | None |
| Risk to Community | None | None |
| Risks to Environment | None | None |
| Estimated Time Frame to Achieve RAOs | Not achieved | 1 month |
| **Implementability** | | |
| Availability of Materials, Equipment, and Skilled Labor | Not Applicable | Straightforward; materials are readily available |
| Ability to Construct and Operate the Remedial Technology | Not Applicable | Readily implemented. |
| Ability to Obtain Permits/Approvals from Agencies | Readily implemented | Permits readily obtainable |
| Ability to Monitor Effectiveness of Remedy | Not Applicable | Readily monitored through signs and work control procedures |
| Ease of Undertaking Additional Actions | Compatible | Compatible |
| Time to Implement | 0 months | 1 month |
| **Cost** | | |
| Total Estimated Capital Cost | $0 | $106,920 |
| Total Estimated Present Worth O&M Cost | $0 | $219,369 |
| Total Present-Worth Costs | $0 | $326,289 |

**Table 11. Comparative Analysis Summary for the MAOU Warranting Action**

| Building | Alternative | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of Toxicity, Mobility, or Volume Through Treatment | Short-Term Effectiveness | Implementability | Cost | Overall Ranking (range 1 – 20) |
|---|---|---|---|---|---|---|---|---|---|
| 313-M | A-1. No Action | No | NA | 1 | NA | 1 | 5 | $0 | 7 |
| | A-4. Passive Soil Vapor Extraction, Institutional Controls | Yes | Yes | 5 | 5 | 4 | 4 | $339,005 | 18 |
| | A-3. Concrete Cap, Institutional Controls | Yes | Yes | 5 | 3 | 4 | 5 | $552,154 | 17 |
| 321-M | A-1. No Action | No | Na | 1 | NA | 1 | 5 | $0 | 7 |
| | A-4. Passive Soil Vapor Extraction, Institutional Controls | Yes | Yes | 5 | 5 | 4 | 4 | $1,283,074 | 18 |
| | A-3. Concrete Cap, Institutional Controls | Yes | Yes | 5 | 3 | 4 | 5 | $782,329 | 17 |
| 320-M | A-1. No Action | No | NA | 1 | NA | 1 | 5 | $0 | 7 |
| | A-4. Passive Soil Vapor Extraction, at MIPSL tie-in, Institutional Controls | Yes | Yes | 5 | 5 | 4 | 4 | $460,620 | 18 |
| | A-3. Concrete Cap, Institutional Controls | Yes | Yes | 5 | 3 | 4 | 5 | $581,201 | 17 |
| 322-M, 341-M, 341-1M, 341-8M, 305-A, 777-10A, 340-M, 324-M, 741-A, 740-A, 743-A | 1. No Action | No | NA | 1 | NA | 1 | 5 | $0 | 7 |
| | 2. Institutional Controls | Yes | Yes | 5 | 0 | 5 | 5 | $326,589 | 15 |

NOTE: Numeric range 1 – 5, where 1 = worst and 5 = best; NA = Not Applicable

The following rationale was used to rank the first 6 of the 9 CERCLA FS criteria.

For the ranking of (1) Overall Protection of Human Health and the Environment, and (2) Compliance with ARARs, the alternatives were simply ranked with a Yes or a No. If the alternative would satisfy the criteria, a Yes is indicated; however, if an alternative would not satisfy the criteria, a No is designated. In instances where a criteria is not addressed an NA is designated. Numerically, an NA is equivalent to a ranking of 0.

For criteria (3) Long-term Effectiveness and Permanence, the alternatives were ranked on the basis of the magnitude of residual risk, adequacy, and the reliability of controls used to manage remaining wastes after the response objectives have been achieved. For the MAOU, all of the alternatives with the exception of the No Action alternative are equivalently ranked a 5 because they offer the highest degree of long-term effectiveness and permanence.

For criteria (4) Reduction of Toxicity, Mobility, or Volume through Treatment, alternative 2 for all the MAOU facilities under evaluation are given the highest ranking 5 because SVE actively reduces toxicity, mobility, and volume through treatment. Alternative 3, cover systems, are given a moderate score of 3 because the alternative does not actively treat the contaminants.

For criteria (5), Short-term Effectiveness, the No Action alternative was given a low ranking of 1 when considering protection of remedial workers, members of the community, and environment during the implementation of the remedial action, and time to achieve RAO/RGOs. Alternatives 2 and 3 for each of the MAOU facilities were equivalently ranked at 4 when accounting the short-term effectiveness factors indicated earlier.

For criteria (6) Implementability, the SVE alternative A-4 is ranked at 4 when considering the technical and administrative feasibility of implementation as well as the availability of necessary equipment and services. Concrete capping is more easily implemented and is ranked with a 5.

**Table 12. List of all MAOU Early Actions/Removal Actions**

| **Building 313-M [Canning Building (Slug Production Facility)]** | | | |
|---|---|---|---|
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| ▪ Radiological contaminants at locations including soil and concrete at 313-M are in excess of PTSM criteria. | ▪ The Autoclave Basement is approximately 2400 $ft^2$ and about 12 ft below grade.<br>▪ The Core Recovery Room sumps together comprise approximately 280 $ft^2$ and are about 4 ft below grade.<br>▪ 21,000 sq. ft 6 inch thick slab | ▪ Remove PTSM to the extent practical.<br>▪ Prevent human exposure to radiological contaminants present on slab surface that present risk to a future industrial worker greater than 1E-06. | ▪ Removal and management of PTSM and > 0.6 pCi/g U-235 and >10 pCi/g U-238 radiological contaminated concrete (off-unit disposal) |
| ▪ VOCs in soil are present at levels approaching PTSM; VOCs are present in the slabs, sumps or vadose zone at concentrations that may impact groundwater above maximum contaminant levels (MCLs). | ▪ The Core Cleaning Solvent Tank Pit is approximately 63 $ft^2$ (7 × 9 ft) and about 3 ft below grade | ▪ Remove VOCs to the extent practical. | ▪ Removal and management of concrete and soil constituting significant sources of VOC contaminated media. |
| **Building 321-M [Fuel Fabrication Building (Manufacturing Building)]** | | | |
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| ▪ Radiological contaminants at locations in concrete at 321-M are in excess of PTSM criteria.<br>▪ Radiological contamination on the slab present a risk greater than 1E-06 for a future industrial worker. | ▪ Approximately one-third of the building has been identified with radiological surface contamination | ▪ Remove PTSM to the extent practical.<br>▪ Prevent human exposure to surficial radiological contaminants present on the building slab that present a risk to a future industrial worker greater than 1E-06. | ▪ Removal and management of radiological contaminated concrete including PTSM (off-unit disposal). |
| ▪ VOCs in soil are present at levels above PTSM.<br>▪ VOCs are present in the slabs, sumps or vadose zone at concentrations that may impact groundwater above MCLs. | ▪ VOC contamination is present at the MIPSL tie-in west of the facility and in the Tube Cleaning Room concrete and soils. | ▪ Prevent migration of VOCs in the slabs, sumps and vadose zone to groundwater above MCLs. | ▪ Removal and management of concrete and soil constituting significant sources for VOC contaminated media. |

**Table 12. List of all MAOU Early Actions/Removal Actions *(Continued)***

| PROBLEMS WARRANTING ACTION | SCOPE | RAOs | EARLY ACTIONS |
|---|---|---|---|
| **Building 320-M (Alloy Building)** | | | |
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| • The brick/concrete base of the Tube Cleaning Pit and the soils below the pipe tie-in near the northwest corner of 320-M contain PCE and/or TCE concentrations greater than 50 mg/kg and are considered to be significant source material. | ▪ VOCs in Tube Cleaning Pit brick/concrete base<br>▪ VOC contamination in soils at MIPSL tie-in west of the facility. | ▪ Remove material at levels constituting a significant source of VOCs to the extent practicable. | ▪ Removal and management of brick/concrete and soil constituting significant sources for VOC contamination. |
| **Building 322-M (Metallurgical Laboratory)** | | | |
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| • Uranium isotopes (U-238) are present in the Room 109 sump and in pipeline sludge at concentrations exceeding PTSM criteria. | ▪ Sludge is present in pipes beneath the slab and the MIPSL connecting 322-M to Manhole 6A. The exact quantity of sludge is not known, although estimates range from 2.2 to 32 kg.<br>▪ The Room 109 sump is approximately 26 $ft^2$.<br>▪ 11,000 sq. ft 6 inch thick slab | ▪ Remove PTSM to the extent practicable.<br>▪ Prevent human exposure to radiological contaminants present on slab surface that present risk to a future industrial worker greater than 1E-06. | ▪ Removal and management of > 0.6 pCi/g U-235 and >10 pCi/g U-238 radiological contaminated concrete and concrete, pipe and sludge contaminated at or above PTSM level to the extent practicable (off – unit disposal). |
| **Building 741-A (Salvage Yard)** | | | |
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| • Surficial soils/gravel contaminants (arsenic, PCBs, PAHs) present a risk greater than 1E-06 for the future industrial worker ($4.0 \times 10^{-5}$). | ▪ The area of contamination for removal is approximately 83.8 by 76.2 m (275 by 250 ft) to a depth of 0.6 m (2ft). | ▪ Prevent human exposure to contaminants present in the surface soil that may present a risk to a future industrial worker greater than 1E-06. | ▪ Excavation of contaminated soils and gravel to be transported to the A-Area Ash Pile (788-2A) and used as nonstructural fill below the soil cover. |
| **Building 341-1M (Dilute Effluent Treatment Facility)** | | | |
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| • Uranium isotopes (U-235 (+D) and U-238 (+D)) identified as HH COCs for external exposure to contaminated concrete wall media. | ▪ 25 sq. ft wall 6 inch thick | ▪ Remove concrete area that exceed a risk of 1E-06 for the future industrial worker. | ▪ Removal and management of > 0.6 pCi/g U-235 and >10 pCi/g U-238 radiological contaminated concrete (off-unit disposal). |

**Table 12. List of all MAOU Early Action/Removal Actions *(Continued/End)***

| **Building341-8M-A (Vendor Treatment Facility)** | | | |
|---|---|---|---|
| **Early Action Scope** | | | |
| **PROBLEMS WARRANTING ACTION** | **SCOPE** | **RAOs** | **EARLY ACTIONS** |
| • Uranium isotopes (U-235 (+D) and U-238 (+D)) identified as HH COCs for external exposure to contaminated concrete slab media. | ▪ 50 sq. ft. slab 6 inch thick | ▪ Remove concrete area that exceed a risk of 1E-06 for the future industrial worker. | ▪ Removal and management of > 0.6 pCi/g U-235 and >10 pCi/g U-238 radiological contaminated concrete (off-unit disposal). |

# APPENDIX A

## Cost Estimates

**Table** **Page**

**Table A-1.** 313-M, 321-M, 320-M, 322-M, 340-M, 324-M, 741-A, 740-A, 743-A, 341-M, 341-1M, 341-8M, 305-A, 777-10A Alternative A-1 ..... 2

**Table A-2.** 313-M Alternative A-4 ..... 3

**Table A-3.** 313-M Alternative A-3 ..... 4

**Table A-4.** 321-M Alternative A-4 ..... 5

**Table A-5** 321-M Alternative A-3 ..... 6

**Table A-6.** 320-M Alternative A-4 ..... 7

**Table A-7.** 320-M Alternative A-3 ..... 8

**Table A-8.** 322-M, 341-M, 341-1M, 341-8M, 305-A, 777-10A, 340-M, 324-M, 741-A, 740-A, 743-A Alternative 2 ..... 9

## Table A-1. 313-M, 321-M, 320-M, 322-M, 340-M, 324-M, 741-A, 740-A, 743-A, 341-M, 341-1M, 341-8M, 305-A, 777-10A Alternative A-1

**No Action**
**M Area OU**
**Savannah River Site**

| Item | | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | | |
| No Action | | | | | | |
| | Subtotal - Direct Capital Cost | | | | $0 | * |
| | Mobilization/Demobilization | 10% | of subtotal direct capital | | $0 | * |
| | Site Preparation/Site Restoration | 10% | of subtotal direct capital | | $0 | * |
| | **Total Direct Capital Cost** | | (sum of * items) | | **$0** | |
| **Indirect Capital Costs** | | | | | | |
| Engineering & Design | | 15% | of direct capital | | $0 | |
| Project/Construction Management | | 25% | of direct capital | | $0 | |
| Health & Safety | | 5% | of direct capital | | $0 | |
| Overhead | | 30% | of direct capital | | $0 | |
| Contingency | | 20% | of direct capital | | $0 | |
| | **Total Indirect Capital Cost** | | | | **$0** | |
| | **Total Estimated Capital Cost** | | | | **$0** | |
| **Direct O&M Costs** | | 3.9% | discount rate for costs > 30 years duration | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | | 30 | year O&M period | *Years 2008 - 2038* | | |
| | Subtotal - Annual Costs | | | | $0 | |
| | Present Worth Annual Costs | | | | $0 | |
| Five Year Costs | | 0 | | | | |
| Remedy Review | | 0 | ea | $15,000 | $0 | |
| | Subtotal - Five Year O&M Costs | | | | $0 | |
| | Present Worth Five Year Costs | | | | $0 | |
| | **Total Present Worth Direct O&M Cost** | | | | **$0** | |
| **Indirect O&M Costs** | | | | | | |
| Project/Admin Management | | 40% | of direct O&M | | $0 | |
| Health & Safety | | 10% | of direct O&M | | $0 | |
| Overhead | | 30% | of direct O&M | | $0 | |
| Contingency | | 15% | of direct O&M | | $0 | |
| | **Total Present Worth Indirect O&M Cost** | | | | **$0** | |
| | **Total Estimated Present Worth O&M Cost** | | | | **$0** | |
| | **TOTAL ESTIMATED COST** | | | | **$0** | |

There are no O&M or 5-year review costs for the No Action alternative, as per EPA-540-R-98-031 guidance.

# Table A-2. 313-M Alternative A-4

**Passive SVE, Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost |
|---|---|---|---|---|
| **Direct Capital Costs** | | | | |
| Baroball Well (2 in well @ 35 ft) | 1 | ea | $3,000 | $3,000 |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 |
| Institutional Controls | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 |
| Subtotal - Direct Capital Cost | | | | $37,200 * |
| Mobilization/Demobilization | 30% of subtotal direct capital | | | $11,160 * |
| Site Preparation/Site Restoration | 30% of subtotal direct capital | | | $11,160 * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$59,520** |
| **Indirect Capital Costs** | | | | |
| Engineering & Design | 20% of direct capital | | | $11,904 |
| Project/Construction Management | 25% of direct capital | | | $14,880 |
| Health & Safety | 6% of direct capital | | | $3,571 |
| Overhead | 30% of direct capital | | | $17,856 |
| Contingency | 20% of direct capital | | | $11,904 |
| **Total Indirect Capital Cost** | | | | **$60,115** |
| **Total Estimated Capital Cost** | | | | **$119,635** |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | 2 years O&M | | | *Years 2008 - 2009* |
| Access Controls | 1 | ea | $500 | $500 |
| Subtotal - Annual Costs | | | | $500 |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 |
| Annual Costs (Institutional Controls) | 10 years O&M | | | *Years 2010 - 2019* |
| Access Controls | 1 | ea | $500 | $500 |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 |
| Subtotal - Annual Costs | | | | $5,500 |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $43,605 |
| Five Year Costs | 3 | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 |
| Subtotal - Five Year O&M Costs | | | | $15,000 |
| Present Worth Five Year Costs | | | | $31,070 |
| **Total Present Worth Direct O&M Cost** | | | | **$75,645** |
| **Indirect O&M Costs** | | | | |
| Project/Admin Management | 124% of direct O&M | | | $93,799 |
| Health & Safety | 21% of direct O&M | | | $15,885 |
| Overhead | 30% of direct O&M | | | $22,693 |
| Contingency | 15% of direct O&M | | | $11,347 |
| **Total Present Worth Indirect O&M Cost** | | | | **$143,725** |
| **Total Estimated Present Worth O&M Cost** | | | | **$219,369** |
| **TOTAL ESTIMATED COST** | | | | **$339,005** |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-3. 313-M Alternative A-3

**Concrete Cap and Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Concrete Cap (No Treatment) | | | | | |
| 6" Concrete Slab over Core Cleaning Solvent Tank Pit | 2000 | sf | $5 | $10,000 | |
| Stormwater Management | 2500 | lf | $25 | $62,500 | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $106,700 | * |
| Mobilization/Demobilization | 25% of subtotal direct capital | | | $26,675 | * |
| Site Preparation/Site Restoration | 25% of subtotal direct capital | | | $26,675 | * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$160,050** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% of direct capital | | | $28,809 | |
| Project/Construction Management | 25% of direct capital | | | $40,013 | |
| Health & Safety | 5% of direct capital | | | $8,003 | |
| Overhead | 30% of direct capital | | | $48,015 | |
| Contingency | 20% of direct capital | | | $32,010 | |
| **Total Indirect Capital Cost** | | | | **$156,849** | |
| **Total Estimated Capital Cost** | | | | **$316,899** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | 2 years O&M | | | *Years 2008 - 2009* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Institutional Controls) | 10 years O&M | | | *Years 2010 - 2019* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Annual Costs | | | | $5,500 | |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $43,605 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$75,645** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 145% of direct O&M | | | $109,685 | |
| Health & Safety | 21% of direct O&M | | | $15,885 | |
| Overhead | 30% of direct O&M | | | $22,693 | |
| Contingency | 15% of direct O&M | | | $11,347 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$159,610** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$235,255** | |
| **TOTAL ESTIMATED COST** | | | | **$552,154** | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-4. 321-M Alternative A-4

**Passive SVE of Stockpiled Soils, Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Prep Infiltration Control Barrier Location | | | | | |
| Excavate Area / Stockpile Soil / Prep Area to Accept Early Actions Soils | 1375 | bcy | $8 | $11,000 | |
| Stockpiled Soil From Early Actions (320-M & 321-M) | | | | | |
| Excavate Stockpiled Soils | 1100 | lcy | $8 | $8,800 | |
| Transport Stockpiled Soils From 320-M and 321-M | 1100 | lcy | $17 | $18,700 | |
| Place / Contour Stockpiled Soils (Machine) | 1100 | lcy | $11 | $12,100 | |
| Place / Contour Stockpiled Soils - Baroball Wells / Perforated Pipe (Hand) | 275 | lcy | $25 | $6,875 | |
| Fab / Install Perforated PVC Pipe (lower level & upper level) - Tie-in to Passive SVE | 3000 | lf | $11 | $33,000 | |
| Infiltration Control Barrier | | | | | |
| Infiltration Barrier - Geosynthetic Clay Layer (GCL) Sealed at Baroball Wells | 16500 | sf | $4 | $66,000 | |
| Equipment Decontamination (Allowance) | 1 | lt | $5,000 | $5,000 | |
| Backfill With Common Fill One Foot Over GCL | 667 | lcy | $31 | $20,677 | |
| Vegetative Layer (1.5 ft Common Fill + 0.5 ft Topsoil) | 1334 | lcy | $35 | $46,690 | |
| Backfill Constituent / Inplace Density Testing | 6 | ea | $250 | $1,500 | |
| Baroball Well (2 in well @ 35 ft) | 16 | ea | $3,000 | $48,000 | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $312,542 | * |
| Mobilization/Demobilization | 25% of subtotal direct capital | | | $78,136 | * |
| Site Preparation/Site Restoration | 25% of subtotal direct capital | | | $78,136 | * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$468,813** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% of direct capital | | | $84,386 | |
| Project/Construction Management | 25% of direct capital | | | $117,203 | |
| Health & Safety | 6% of direct capital | | | $28,129 | |
| Overhead | 30% of direct capital | | | $140,644 | |
| Contingency | 20% of direct capital | | | $93,763 | |
| **Total Indirect Capital Cost** | | | | **$464,125** | |
| **Total Estimated Capital Cost** | | | | **$932,938** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | | 2 years O&M | | *Years 2008 - 2009* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Passive Soil Vapor Extraction Operation - Baroballs) | | 10 years O&M | | *Years 2010 - 2019* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections | 1 | ea | $5,000 | $5,000 | |
| Performance Analysis Report | 1 | ea | $10,000 | $10,000 | |
| Subtotal - Annual Costs | | | | $15,500 | |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $122,888 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$154,927** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 71% of direct O&M | | | $109,998 | |
| Health & Safety | 10% of direct O&M | | | $15,493 | |
| Overhead | 30% of direct O&M | | | $46,478 | |
| Contingency | 15% of direct O&M | | | $23,239 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$195,208** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$350,136** | |
| **TOTAL ESTIMATED COST** | | | | **$1,283,074** | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-5 321-M Alternative A-3

**Concrete Caps and Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Concrete Cap (No Treatment) | | | | | |
| 321-M (324 cy) - 6" concrete over existing concrete | 17500 | sf | $5 | $87,500 | |
| Stormwater Management | 2500 | lf | $25 | $62,500 | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $184,200 | * |
| Mobilization/Demobilization | 25% of subtotal direct capital | | | $46,050 | * |
| Site Preparation/Site Restoration | 25% of subtotal direct capital | | | $46,050 | * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$276,300** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% of direct capital | | | $49,734 | |
| Project/Construction Management | 25% of direct capital | | | $69,075 | |
| Health & Safety | 5% of direct capital | | | $13,815 | |
| Overhead | 30% of direct capital | | | $82,890 | |
| Contingency | 20% of direct capital | | | $55,260 | |
| **Total Indirect Capital Cost** | | | | **$270,774** | |
| **Total Estimated Capital Cost** | | | | **$547,074** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | 2 years O&M | | *Years 2008 - 2009* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Institutional Controls) | 10 years O&M | | *Years 2010 - 2019* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Annual Costs | | | | $5,500 | |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $43,605 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$75,645** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 145% of direct O&M | | | $109,685 | |
| Health & Safety | 21% of direct O&M | | | $15,885 | |
| Overhead | 30% of direct O&M | | | $22,693 | |
| Contingency | 15% of direct O&M | | | $11,347 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$159,610** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$235,255** | |
| **TOTAL ESTIMATED COST** | | | | **$782,329** | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-6. 320-M Alternative A-4

**Passive SVE at MIPSL Tie-in and Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Baroball Well (2 in well @ 35 ft) | 1 | ea | $3,000 | $3,000 | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $37,200 | * |
| Mobilization/Demobilization | 25% of subtotal direct capital | | | $9,300 | * |
| Site Preparation/Site Restoration | 25% of subtotal direct capital | | | $9,300 | * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$55,800** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% of direct capital | | | $10,044 | |
| Project/Construction Management | 25% of direct capital | | | $13,950 | |
| Health & Safety | 5% of direct capital | | | $2,790 | |
| Overhead | 30% of direct capital | | | $16,740 | |
| Contingency | 20% of direct capital | | | $11,160 | |
| **Total Indirect Capital Cost** | | | | **$54,684** | |
| **Total Estimated Capital Cost** | | | | **$110,484** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | 2 years O&M | | *Years 2008 - 2009* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Passive Soil Vapor Extraction Operation - Baroballs) | 10 years O&M | | *Years 2009 - 2019* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 | |
| Performance Analysis Report | 1 | ea | $10,000 | $10,000 | |
| Subtotal - Annual Costs | | | | $15,500 | |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $122,888 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$154,927** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 71% of direct O&M | | | $109,998 | |
| Health & Safety | 10% of direct O&M | | | $15,493 | |
| Overhead | 30% of direct O&M | | | $46,478 | |
| Contingency | 15% of direct O&M | | | $23,239 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$195,208** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$350,136** | |
| **TOTAL ESTIMATED COST** | | | | **$460,620** | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-7. 320-M Alternative A-3

**Concrete Caps and Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Concrete Cap (No Treatment) | | | | | |
| 320-M (47 cy) - 6" concrete over existing concrete | 2500 | sf | $5 | $12,500 | |
| Stormwater Management | 2500 | lf | $25 | $62,500 | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 4 | ea | $50 | $200 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $109,200 | * |
| Mobilization/Demobilization | 30% | of subtotal direct capital | | $32,760 | * |
| Site Preparation/Site Restoration | 30% | of subtotal direct capital | | $32,760 | * |
| **Total Direct Capital Cost** | | (sum of * items) | | **$174,720** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% | of direct capital | | $31,450 | |
| Project/Construction Management | 25% | of direct capital | | $43,680 | |
| Health & Safety | 5% | of direct capital | | $8,736 | |
| Overhead | 30% | of direct capital | | $52,416 | |
| Contingency | 20% | of direct capital | | $34,944 | |
| **Total Indirect Capital Cost** | | | | **$171,226** | |
| **Total Estimated Capital Cost** | | | | **$345,946** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | | 2 years O&M | | *Years 2008 - 2009* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Institutional Controls) | | 10 years O&M | | *Years 2010 - 2019* | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Annual Costs | | | | $5,500 | |
| Present Worth Annual Costs (3.1% Discount Rate) | | | | $43,605 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$75,645** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 145% | of direct O&M | | $109,685 | |
| Health & Safety | 21% | of direct O&M | | $15,885 | |
| Overhead | 30% | of direct O&M | | $22,693 | |
| Contingency | 15% | of direct O&M | | $11,347 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$159,610** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$235,255** | |
| **TOTAL ESTIMATED COST** | | | | $581.201 | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Table A-8.
# 322-M, 341-M, 341-1M, 341-8M, 305-A, 777-10A, 340-M, 324-M, 741-A, 740-A, 743-A
# Alternative 2

**Institutional Controls**
**M Area OU**
**Savannah River Site**

| Item | Quantity | Units | Unit Cost | Total Cost | |
|---|---|---|---|---|---|
| **Direct Capital Costs** | | | | | |
| Plug Manhole Inverts and Grout Manholes | 12 | ea | $2,000 | $24,000 | |
| Institutional Controls | | | | | |
| Posting of Warning Signs | 40 | ea | $50 | $2,000 | |
| Land Use Control Implementation Plan | 1 | ea | $5,000 | $5,000 | |
| Deed Restrictions | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Direct Capital Cost | | | | $36,000 | * |
| Mobilization/Demobilization | 25% of subtotal direct capital | | | $9,000 | * |
| Site Preparation/Site Restoration | 25% of subtotal direct capital | | | $9,000 | * |
| **Total Direct Capital Cost** | (sum of * items) | | | **$54,000** | |
| **Indirect Capital Costs** | | | | | |
| Engineering & Design | 18% of direct capital | | | $9,720 | |
| Project/Construction Management | 25% of direct capital | | | $13,500 | |
| Health & Safety | 5% of direct capital | | | $2,700 | |
| Overhead | 30% of direct capital | | | $16,200 | |
| Contingency | 20% of direct capital | | | $10,800 | |
| **Total Indirect Capital Cost** | | | | **$52,920** | |
| **Total Estimated Capital Cost** | | | | **$106,920** | |
| **Direct O&M Costs** | 3.9% discount rate for costs > 30 years duration[1] | | | | |
| Annual Costs (Existing System during Post-ROD Design & Const) | 2 years O&M | | *Years 2008 - 2009* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Subtotal - Annual Costs | | | | $500 | |
| Present Worth Annual Costs (2.1% Discount Rate) | | | | $969 | |
| Annual Costs (Institutional Controls) | 10 years O&M | | *Years 2009 - 2019* | | |
| Access Controls | 1 | ea | $500 | $500 | |
| Annual Inspections / Maintenance | 1 | ea | $5,000 | $5,000 | |
| Subtotal - Annual Costs | | | | $5,500 | |
| Present Worth Annual Costs (3.2% Discount Rate) | | | | $43,605 | |
| Five Year Costs | 3 | | | | |
| Remedy Review | 1 | ea | $15,000 | $15,000 | |
| Subtotal - Five Year O&M Costs | | | | $15,000 | |
| Present Worth Five Year Costs | | | | $31,070 | |
| **Total Present Worth Direct O&M Cost** | | | | **$75,645** | |
| **Indirect O&M Costs** | | | | | |
| Project/Admin Management | 124% of direct O&M | | | $93,799 | |
| Health & Safety | 21% of direct O&M | | | $15,885 | |
| Overhead | 30% of direct O&M | | | $22,693 | |
| Contingency | 15% of direct O&M | | | $11,347 | |
| **Total Present Worth Indirect O&M Cost** | | | | **$143,725** | |
| **Total Estimated Present Worth O&M Cost** | | | | **$219,369** | |
| **TOTAL ESTIMATED COST** | | | | **$326,289** | |

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

# Appendix B

## Recalculation of Soil CM RGOs for MAOU Early Actions, Results of MIPSL Manhole Tests and Contaminant Migration Analysis for Final Actions

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## I. INTRODUCTION

The M-Area is located in the northwest quadrant of the Savannah River Site (SRS), adjacent to A-Area. The M-Area is the second area at SRS that is addressed under an area-wide remedial strategy. As part of this strategy, the facilities in the former M-Area industrial area were consolidated into a single operable unit, the M Area Operable Unit (MAOU). The MAOU is comprised of waste units and facilities that have been combined based on physical location, similar conceptual site models, and common problems warranting action. At this time, all of the MAOU facilities in the Production Area have undergone Deactivation and Decommissioning (D&D), including demolition and removal and field characterization for remaining contaminants.

As part of this process, SRS prepared documentation, including the *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan, RFI/RI Report with Baseline Risk Assessment (BRA) and Corrective Measures Study/Feasibility Study* (WSRC 2007). This document is known as the "MAOU Combined Document" and describes field characterization activities and data, contaminant migration (CM) and risk evaluations, and remediation alternatives for the MAOU. The MAOU Combined Document (Revision 1) was approved by the South Carolina Department of Health and Environmental Control on August 21, 2007 and the U.S. Environmental Protection Agency on September 20, 2007.

The remedial action objectives (RAOs) described in the MAOU Combined Document include 'early actions' involving the removal (to the extent practicable) of radionuclides and volatile organic compounds (VOCs) that are categorized as principal threat source material (PTSM), as well as other significant sources of VOC contamination in soil and radiological contamination in the concrete building slabs. In this case, other significant sources are defined as tetrachloroethylene (PCE) or trichloroethylene (TCE) concentrations in soil exceeding 50 mg/kg. As part of this documentation, CM remedial goal options (CM RGOs) were calculated to identify maximum soil PCE or TCE contaminant levels that are not predicted to impact groundwater (i.e., leaching through the vadose zone results in predicted groundwater concentrations greater than the MCL, 5 μg/L).

The details of the MAOU early actions related to VOCs (including technologies deployed for soil removal and treatment) are presented in the Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis (RSER/EECA) documents (WSRC 2006a and 2006b). The early actions for PCE/TCE involve the following four facilities: 1) 321-M (Tube Cleaning Room/MIPSL Tie-in Area), 2) 320-M (MIPSL Tie-in Area), 3) 320-M (Tube Cleaning Pit Area), and 4) 313-M (Core Cleaning Solvent Tank Pit Area). These "VOC contaminated soil and concrete removal areas" are described in the MAOU Combined Document. The early actions for radiological contaminants in concrete slabs involve the following facilities: 1) 341-1M Interim Treatment Storage Facility, 2) 341-8M Vendor Treatment Facility, 3) 322-M Metallurgical Laboratory, 4) 321-M Machining/ Casting rooms, and 5) 313-M Slug Production Facility. A summary level discussion of the removal actions and contaminant levels during and after the actions is provided in Section 8 of this appendix.

The purpose of Appendix B is to document the recalculation of soil CM RGOs for PCE/TCE based on the expected waste unit configurations after the Production Area VOC early actions are completed and to estimate the effects of final actions including PCE removal rates and treatment durations. It was expected that the recalculated early action soil CM RGOs would increase (as compared to pre-early action CM RGOs). The recalculated Remedial Goals (after the early action removals are completed) will eventually be documented in the Record of Decision (ROD) for the MAOU.

In addition, soil boring data from three MIPSL areas and two MAOU facilities were tested to see if the detected PCE soil concentrations would leach through the vadose zone and impact groundwater substantially above the MCL. These tests include: 1) MIPSL Manhole 5, 2) MIPSL Manhole 4A, 3) MIPSL Manhole 6A, 4) 320-M Tube Cleaning Pit Area, and 5) 313-M Core Cleaning Solvent Tank Pit Area.

This calc-note is divided into the following sections to describe soil leachability modeling and calculation of MAOU early action CM RGOs; Section 2. - Modeling Methods, Section 3. - Modeling Parameters, Section 4. - Assumptions, Section 5. - Simulated Water Balance, Section 6. – Summary of Model Set-up and Early Action

Computations, Section 7. - Summary of Early Action Model Predictions, Section 8. - Summary of MAOU Remedial Actions and Contaminant Levels During and After Early Actions, and Section 9. - Final Action Contaminant Migration Analysis and Estimate of Remediation Treatment Time.

## 2. MODELING METHODS

Nine 1-D soil leachability model simulations were performed for shallow subsurface conditions at the MAOU Production Area. These model simulations were used to:

1. Recalculate the CM RGO (PCE) for the 321-M Tube Cleaning Room/MIPSL Tie-in Area for conditions after the early action (70% of soil removed to 42 ft bgs and backfill).

2. Recalculate the CM RGO (TCE) for the 320-M MIPSL Tie-in Area for conditions after the early action (70% of soil removed to 30 ft bgs and backfill).

3. Recalculate the CM RGO (PCE) for the 320-M Tube Cleaning Pit Area for conditions after the early action (soil removed to 10 ft bgs and backfill), CM RGO calculated for soil beneath the excavation (10-22 ft bgs).

4. Recalculate the CM RGO (PCE) for the 313-M Core Cleaning Solvent Tank Pit Area for conditions after the early action (soil removed to 20 ft bgs and backfill), CM RGO calculated for soil beneath the excavation (20-32 ft bgs).

5. Predict if existing soil contamination by PCE will impact groundwater at MIPSL Manhole 5 (no early action) using data from a nearby soil boring.

6. Predict if existing soil contamination by PCE will impact groundwater at MIPSL Manhole 4A (no early action) using data from a nearby soil boring.

7. Predict if existing soil contamination by PCE will impact groundwater at MIPSL Manhole 6A (no early action) using data from a nearby soil boring.

8. Predict if residual soil contamination by PCE (deeper than 10 ft bgs, using data from a nearby soil boring) will impact groundwater at the 320-M Tube Cleaning Pit Area.

9. Predict if residual soil contamination by PCE (deeper than 20 ft bgs, using data from a nearby soil boring) will impact groundwater at the 313-M Core Cleaning Solvent Tank Pit Area.

In order to simulate the affects of the early action removals on CM, the residual contaminant mass and distribution of the residual contaminants must be considered. The early actions at both 321-M and 320-M involve removing contaminated soil using a large auger (approx. 8 feet in diameter). After excavation the auger holes will be filled with clean sandy fill. The models for 321-M and 320-M take as fact that 70% of the contaminated soil will be removed and the auger holes backfilled with clean fill. The thickness of the remaining soil for both areas was calculated by comparing pre-excavation and post-excavation volumes (as if the remaining soil is a homogeneous layer in the bottom of the pit). The calculated residual soil thickness is 12 ft for 321-M and 9 ft for 320-M. The residual soil concentrations tested for each model iteration were loaded into model layer 1 and the layer 1 sublayers representing 30-42 ft bgs for 321-M, and 21-30 ft bgs for 320-M. The recalculated early actions CM RGOs are the maximum concentrations in soil where the predicted groundwater concentration does not exceed the MCL for PCE and TCE (5 $\mu$g/L).

Since residual contamination will exist below the excavation at 321-M, the PCE analytical results from MIPS-SB045 soil borings deeper than 42 ft were used for the 321-M model (i.e., did not change during model iterations). It is assumed that residual contamination does not exist beneath the 320-M MIPSL Tie-in Area excavation, so only the TCE in a homogeneous layer was simulated. This assumption is verified as the average TCE concentration detected in grab samples collected from the base of the excavation is 0.6 mg/kg and the maximum is 2.6 mg/kg. For the 320-M Tube Cleaning Pit and 313-M Core Cleaning Solvent Tank Pit CM RGO calculations, 100% of the soil was removed and the excavations were backfilled. Therefore, the models were used to iterate upon the maximum PCE concentrations directly below the excavations that will not exceed the MCL in groundwater. Since soil boring data are available for these locations and for MIPSL Manholes 5, 4A and 6A, the data for depths beneath the excavation and for the entire soil column at these locations were entered into the models to see if groundwater impacts greater than the MCL would occur.

The programs SEVIEW v.6.2.9 (ESCI 2004) and SESOIL (Bonazountas and Wagener, 1981) were used for the calculation. SEVIEW is the graphical user interface (GUI) used for accessing and running the SESOIL program and for processing the results. The functionality of SEVIEW was verified in the document, *SEVIEW Software Evaluation Test* (WSRC 2004a). SESOIL is a 1-D, vadose zone transport model and uses a simple dilution model for calculating groundwater concentrations. Within SESOIL, contaminant phase distributions in the vadose zone are predicted at discrete points in time along with contaminant volume/mass and transport time to the water table. The model input values used for the SESOIL simulations are presented in Section 3.

## 3. MODELING PARAMETERS

The model input parameters used are provided below in Tables 3-1 to 3-9. The tables include the vertical soil profiles (model layer thickness), soil parameters, chemical parameters (PCE or TCE), contaminant source concentrations and model sublayer load. The parameters from the SEVIEW chemical database (solubility, molecular weight, Henry's Law coefficient, air-diffusion coefficient, water diffusion coefficient, organic carbon partitioning coefficient) are also used for modeling. The model parameters from a recent SRS groundwater flow model were used for the Summers Model (WSRC 2005). These parameters are listed in Table 3-10.

**Table 3-1. 321-M SESOIL Profile, Modeling Parameters and PCE Loading for the CM RGO Recalculation**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm $^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 1280.0 | 41.99 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3020.0 | 99.08 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density (g/cm3) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm $^2$ | 2.10E+6 |
| | ft $^2$ | 2260.42 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law (M$^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient (cm$^2$/sec) | 5.35 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient (cm$^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\321E21.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | 3.00E+00 | 3.00E+00 | 3.00E+00 |
| Layer 2 (ug/g) | 2.40E+00 | 1.50E-01 | 1.50E-01 | 1.50E-01 | 1.50E-01 | 5.00E-02 | 5.00E-02 | 5.00E-02 | 5.00E-02 | 5.00E-02 |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-2. 320-M MIPSL Tie-in Area SESOIL Profile, Modeling Parameters and TCE Loading for the CM RGO Recalculation**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm $^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 914.0 | 29.99 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3380.0 | 110.89 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density (g/cm3) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm $^2$ | 2.00E+5 |
| | ft $^2$ | 215.28 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 1.10E+3 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law (M $^3$atm/mol) | 1.17E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 166.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient (cm $^2$/sec) | 3.95 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient (cm $^2$/sec) | 9.10E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 131.00 | | |

**Output File:**
C:\SEVIEW62\320T6.OUT
**Chemical File:** Trichloroethylene (TCE)
C:\SEVIEW62\TCE.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | 1.50E+01 | 1.50E+01 | 1.50E+01 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-3. 320-M Tube Cleaning Pit SESOIL Profile, Modeling Parameters and PCE Loading for the CM RGO Recalculation**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm $^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3990.0 | 130.91 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density (g/cm3) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm $^2$ | 1.40E+5 |
| | ft $^2$ | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law (M $^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient (cm $^2$/sec) | .720 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient (cm $^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\320S17.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 2.80E+00 | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-4. 313-M SESOIL Profile, Modeling Parameters and PCE Loading for the CM RGO Recalculation**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm 2 | percent | μg/g / μg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | (g/cm3) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm 2 | 1.40E+5 |
| | ft 2 | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility (μg/mL) | 200.0 | | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law (M 3atm/mol) | 2.68E-2 | | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (μg/g)/(μg/mL) | 155.00 | | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient (cm2/sec) | .720 | | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient (cm2/sec) | 8.20E-6 | | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | | |

**Output File:**
C:\SEVIEW62\313S12.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 1.80E+00 | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-5. MIPSL Manhole 5 SESOIL Profile, Modeling Parameters and PCE Loading using Soil Boring Data**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm 2 | percent | μg/g / μg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | (g/cm3) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm 2 | 2.00E+5 |
| | ft 2 | 215.28 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility (μg/mL) | 200.0 | | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law (M 3atm/mol) | 2.68E-2 | | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (μg/g)/(μg/mL) | 155.00 | | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient (cm2/sec) | 7.20E-2 | | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient (cm2/sec) | 8.20E-6 | | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | | |

**Output File:**
C:\SEVIEW62\313MP7.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | 1.50E-01 | | 5.20E-02 | | 4.30E-01 | | | | | 1.00E+00 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-6. MIPSL Manhole 4A SESOIL Profile, Modeling Parameters and PCE Loading using Soil Boring Data**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm $^2$ | percent | μg/g / μg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | (g/cm3) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm $^2$ | 2.09E+5 |
| | ft $^2$ | 224.97 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility | (μg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law | (M $^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ | (μg/g)/(μg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance | (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient | (cm $^2$/sec) | 7.20E-2 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient | (cm $^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight | (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\MP4A3.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | 3.00E-03 | 7.00E-03 | 5.20E-03 | | 1.40E-01 | | | | | 2.00E+00 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-7. MIPSL Manhole 6A SESOIL Profile, Modeling Parameters and PCE Loading using Soil Boring Data**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | cm $^2$ | percent | μg/g / μg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | (g/cm3) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | cm $^2$ | 1.40E+5 |
| | ft $^2$ | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility | (μg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law | (M $^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ | (μg/g)/(μg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance | (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient | (cm $^2$/sec) | 7.20E-2 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient | (cm $^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight | (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\MP6A3.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | 1.38E-01 | | 2.91E-01 | | 1.10E+00 | | | | | 1.23E-01 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-8. 320-M Tube Cleaning Pit SESOIL Profile, Modeling Parameters and PCE Loading Using Soil Boring Data**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3990.0 | 130.91 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density ($g/cm^3$) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 1.40E+5 |
| | $ft^2$ | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law ($M^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight (g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate (L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient ($cm^2$/sec) | .720 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient ($cm^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\320S18.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 4.30E-01 | 8.50E-02 | 4.00E-03 | 8.00E-03 | | | 2.70E-03 | 2.10E-03 | 1.00E-03 | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-9. 313-M SESOIL Profile, Modeling Parameters and PCE Loading using Soil Boring Data**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density ($g/cm^3$) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 1.40E+5 |
| | $ft^2$ | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law ($M^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight (g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate (L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient ($cm^2$/sec) | .720 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient ($cm^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\313S13.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 3.30E+00 | 2.70E+00 | 5.70E-02 | 5.40E-02 | 5.40E-02 | 9.00E-03 | 6.00E-03 | 2.00E-03 | 2.00E-03 | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 3-10. Summers Groundwater Dilution Model Parameters**

| Summers Model Parameters | Value Used |
|---|---|
| Saturated Hydraulic Conductivity | $1.8 \times 10^{-4}$ cm/sec |
| Hydraulic Gradient | 0.004 m/m |
| Thickness of Groundwater Mixing Zone | $3.3 \times 10^{3}$ cm |
| Contaminant Width Perpendicular to Groundwater Flow | $1.7 \times 10^{3}$ cm |

## 4. ASSUMPTIONS

The assumptions that apply to the SESOIL models and this calculation are listed below:

- The model prediction uncertainty of the 1-D, vadose zone transport modeling approach and simple dilution model (for groundwater) are assumed to be adequate for this project. The model parameter uncertainty was managed by conceptualizing and simulating the conditions and transport processes occurring at each location using analytical data from soil borings, observed soil layer thickness, and SEVIEW database information that is reflective of site conditions. The database information includes soil property parameters, chemical property parameters, local climate information and soil permeability values for soil types observed.

- The SEVIEW climate database file for Aiken, SC (filename = Aiken4NE) was used for modeling. This file contains climate parameters averaged over a 10-year period. To achieve a reasonable water balance for the MAOU simulations, it was necessary to reduce the evapotranspiration rates by a factor of two. It is assumed that reducing the evapotranspiration is reasonable for these simulations, given the fact that plant life will be sparse or absent in these areas.

- The maximum VOC detected at each area of the facilities modeled (either PCE or TCE) was used to represent and simulate VOCs. An average of PCE concentrations in soil (from soil boring data) were calculated for the same sample depths and used for the initial contaminant load in the 321-M Tube Cleaning Room/MIPSL Tie-in Area, 320-M Tube Cleaning Pit Area, 313-M Core Cleaning Solvent Tank Pit Area, and for MIPSL Manholes (5, 4A and 6A) simulations. Similarly, average TCE concentrations were calculated and used for the initial contaminant load in the 320-M MIPSL Tie-in Area. Any remaining PCE/TCE source in the concrete slabs is not considered in these calculations.

- Since clean backfill will be used to fill the 321-M, 320-M and 313-M excavations, the air-diffusion term was increased by a factor of 75 for PCE at 321-M Tube Cleaning Room/MIPSL Tie-in Area (installation of sand columns over a large area), a factor of 50 for TCE at 320-M MIPSL Tie-in Area (installation of sand columns over a smaller area), and a factor of 10 for PCE at 320-M Tube Cleaning Pit Area and 313-M Core Cleaning Solvent Tank Pit Area (both excavation and backfill). It is assumed that these values represent the chemical gradient produced by the clean backfill and molecular (vapor) diffusion back into the backfill. The air diffusion coefficient term was not changed for the other model simulations (Manholes 5, 4A and 6A).

- It is assumed that an "instantaneous release" condition is appropriate and representative of source load and leaching conditions. In SESOIL, an instantaneous release source load approach means that contaminant mass is applied in sublayer 1 of layer 1 for the first day of the month, but divided into 30 daily loads for layers 2 to 4. The instantaneous release source load is applied for the first month of the first year of the simulation.

- It is assumed that the source loading areas used for modeling are representative of existing contamination. The source loading areas are based on the planned excavation for 321-M, 320-M MIPSL Tie-in Area, 320-M Tube Cleaning Pit and 313-M. For the manhole tests and for the 320-M Tube Cleaning Pit and 313-M simulations where soil boring data were used, it is assumed that contamination areas represented by the soil borings represent the extent of contamination.

## 5. SIMULATED WATER BALANCE

Prior to transport modeling, a reasonable simulated water balance was achieved for the SESOIL Hydrologic cycle. A separate water balance was achieved for each of the nine models.

The SESOIL Hydrologic Cycle reports showing the water balances are in Tables 5-1 to 5-7. As shown in the tables, groundwater recharge varies from 9 to 11 in/yr, and surface water runoff and evapotranspiration both range from 19 to 21 in/yr. The soil moisture ranges from 16-19%. These values are within the normal ranges expected at SRS.

**Table 5-1. 321-M SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 2.89 | 1.14 | 4.35 | 1.71 | 3.34 | 1.31 | -0.99 | -0.39 | 1.99 | 0.78 | 16.75 | 16.75 |
| November | 2.97 | 1.17 | 4.33 | 1.70 | 2.43 | 0.96 | 0.12 | 0.05 | 1.77 | 0.70 | 16.78 | 16.78 |
| December | 3.04 | 1.20 | 6.64 | 2.61 | 1.82 | 0.72 | 2.98 | 1.17 | 1.84 | 0.72 | 17.54 | 17.54 |
| January | 4.56 | 1.80 | 7.13 | 2.81 | 2.13 | 0.84 | 2.98 | 1.17 | 2.03 | 0.80 | 18.30 | 18.30 |
| February | 4.64 | 1.83 | 6.76 | 2.66 | 3.65 | 1.44 | 0.87 | 0.34 | 2.24 | 0.88 | 18.52 | 18.52 |
| March | 5.38 | 2.12 | 8.11 | 3.19 | 5.17 | 2.04 | 0.37 | 0.15 | 2.57 | 1.01 | 18.61 | 18.61 |
| April | 3.74 | 1.47 | 5.95 | 2.34 | 5.47 | 2.15 | -2.11 | -0.83 | 2.58 | 1.02 | 18.08 | 18.08 |
| May | 3.63 | 1.43 | 6.94 | 2.73 | 5.78 | 2.28 | -1.49 | -0.59 | 2.66 | 1.05 | 17.70 | 17.70 |
| June | 5.41 | 2.13 | 7.56 | 2.98 | 6.08 | 2.39 | -1.24 | -0.49 | 2.72 | 1.07 | 17.38 | 17.38 |
| July | 4.85 | 1.91 | 8.35 | 3.29 | 6.38 | 2.51 | -0.74 | -0.29 | 2.71 | 1.07 | 17.19 | 17.19 |
| August | 5.39 | 2.12 | 8.17 | 3.22 | 5.78 | 2.28 | -0.25 | -0.10 | 2.64 | 1.04 | 17.13 | 17.13 |
| September | 3.01 | 1.19 | 6.06 | 2.39 | 4.56 | 1.80 | -0.87 | -0.34 | 2.36 | 0.93 | 16.91 | 16.91 |
| Total | 49.49 | 19.49 | 80.33 | 31.63 | 52.59 | 20.71 | -0.37 | -0.15 | 28.11 | 11.07 | | |

**Table 5-2. 320-M MIPSL Tie-in Area SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 2.97 | 1.17 | 4.25 | 1.67 | 3.34 | 1.31 | -0.99 | -0.39 | 1.90 | 0.75 | 16.91 | 16.91 |
| November | 3.05 | 1.20 | 4.25 | 1.67 | 2.43 | 0.96 | 0.12 | 0.05 | 1.69 | 0.67 | 16.94 | 16.94 |
| December | 3.16 | 1.24 | 6.55 | 2.58 | 1.82 | 0.72 | 2.98 | 1.17 | 1.75 | 0.69 | 17.70 | 17.70 |
| January | 4.73 | 1.86 | 7.03 | 2.77 | 2.13 | 0.84 | 2.98 | 1.17 | 1.93 | 0.76 | 18.46 | 18.46 |
| February | 4.80 | 1.89 | 6.65 | 2.62 | 3.65 | 1.44 | 0.87 | 0.34 | 2.13 | 0.84 | 18.68 | 18.68 |
| March | 5.45 | 2.15 | 7.85 | 3.09 | 5.17 | 2.04 | 0.25 | 0.10 | 2.43 | 0.96 | 18.74 | 18.74 |
| April | 3.83 | 1.51 | 5.81 | 2.29 | 5.47 | 2.15 | -2.11 | -0.83 | 2.45 | 0.96 | 18.20 | 18.20 |
| May | 3.73 | 1.47 | 6.80 | 2.68 | 5.78 | 2.28 | -1.49 | -0.59 | 2.51 | 0.99 | 17.83 | 17.83 |
| June | 5.55 | 2.19 | 7.42 | 2.92 | 6.08 | 2.39 | -1.24 | -0.49 | 2.58 | 1.02 | 17.51 | 17.51 |
| July | 4.99 | 1.96 | 8.21 | 3.23 | 6.38 | 2.51 | -0.74 | -0.29 | 2.57 | 1.01 | 17.32 | 17.32 |
| August | 5.54 | 2.18 | 8.03 | 3.16 | 5.78 | 2.28 | -0.25 | -0.10 | 2.51 | 0.99 | 17.26 | 17.26 |
| September | 3.09 | 1.22 | 5.93 | 2.33 | 4.56 | 1.80 | -0.87 | -0.34 | 2.24 | 0.88 | 17.04 | 17.04 |
| Total | 50.88 | 20.03 | 78.79 | 31.02 | 52.59 | 20.71 | -0.50 | -0.20 | 26.69 | 10.51 | | |

**Table 5-3. 320-M Tube Cleaning Pit Area SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.06 | 1.20 | 4.10 | 1.61 | 3.34 | 1.31 | -0.99 | -0.39 | 1.75 | 0.69 | 17.09 | 17.09 |
| November | 3.15 | 1.24 | 4.11 | 1.62 | 2.43 | 0.96 | 0.12 | 0.05 | 1.56 | 0.61 | 17.12 | 17.12 |
| December | 3.32 | 1.31 | 6.41 | 2.52 | 1.82 | 0.72 | 2.98 | 1.17 | 1.61 | 0.63 | 17.88 | 17.88 |
| January | 4.95 | 1.95 | 6.88 | 2.71 | 2.13 | 0.84 | 2.98 | 1.17 | 1.77 | 0.70 | 18.63 | 18.63 |
| February | 5.00 | 1.97 | 6.47 | 2.55 | 3.65 | 1.44 | 0.87 | 0.34 | 1.96 | 0.77 | 18.85 | 18.85 |
| March | 5.69 | 2.24 | 7.65 | 3.01 | 5.17 | 2.04 | 0.25 | 0.10 | 2.23 | 0.88 | 18.92 | 18.92 |
| April | 4.07 | 1.60 | 5.74 | 2.26 | 5.47 | 2.15 | -1.98 | -0.78 | 2.26 | 0.89 | 18.41 | 18.41 |
| May | 3.90 | 1.54 | 6.61 | 2.60 | 5.78 | 2.28 | -1.49 | -0.59 | 2.32 | 0.91 | 18.04 | 18.04 |
| June | 5.78 | 2.28 | 7.22 | 2.84 | 6.08 | 2.39 | -1.24 | -0.49 | 2.38 | 0.94 | 17.72 | 17.72 |
| July | 5.22 | 2.06 | 8.01 | 3.15 | 6.38 | 2.51 | -0.74 | -0.29 | 2.37 | 0.93 | 17.53 | 17.53 |
| August | 5.67 | 2.23 | 7.71 | 3.04 | 5.78 | 2.28 | -0.37 | -0.15 | 2.30 | 0.91 | 17.44 | 17.44 |
| September | 3.21 | 1.26 | 5.75 | 2.26 | 4.56 | 1.80 | -0.87 | -0.34 | 2.06 | 0.81 | 17.22 | 17.22 |
| Total | 53.00 | 20.87 | 76.66 | 30.18 | 52.59 | 20.71 | -0.49 | -0.19 | 24.57 | 9.67 | | |

**Table 5-4. 313-M SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.01 | 1.19 | 4.17 | 1.64 | 3.34 | 1.31 | -0.99 | -0.39 | 1.82 | 0.72 | 17.00 | 17.00 |
| November | 3.10 | 1.22 | 4.18 | 1.65 | 2.43 | 0.96 | 0.12 | 0.05 | 1.62 | 0.64 | 17.03 | 17.03 |
| December | 3.24 | 1.28 | 6.48 | 2.55 | 1.82 | 0.72 | 2.98 | 1.17 | 1.67 | 0.66 | 17.79 | 17.79 |
| January | 4.84 | 1.91 | 6.95 | 2.74 | 2.13 | 0.84 | 2.98 | 1.17 | 1.85 | 0.73 | 18.55 | 18.55 |
| February | 4.90 | 1.93 | 6.56 | 2.58 | 3.65 | 1.44 | 0.87 | 0.34 | 2.04 | 0.80 | 18.77 | 18.77 |
| March | 5.57 | 2.19 | 7.74 | 3.05 | 5.17 | 2.04 | 0.25 | 0.10 | 2.33 | 0.92 | 18.83 | 18.83 |
| April | 4.00 | 1.57 | 5.84 | 2.30 | 5.47 | 2.15 | -1.98 | -0.78 | 2.35 | 0.93 | 18.33 | 18.33 |
| May | 3.82 | 1.50 | 6.71 | 2.64 | 5.78 | 2.28 | -1.49 | -0.59 | 2.42 | 0.95 | 17.95 | 17.95 |
| June | 5.68 | 2.24 | 7.32 | 2.88 | 6.08 | 2.39 | -1.24 | -0.49 | 2.48 | 0.98 | 17.63 | 17.63 |
| July | 5.11 | 2.01 | 8.11 | 3.19 | 6.38 | 2.51 | -0.74 | -0.29 | 2.47 | 0.97 | 17.44 | 17.44 |
| August | 5.68 | 2.24 | 7.94 | 3.13 | 5.78 | 2.28 | -0.25 | -0.10 | 2.42 | 0.95 | 17.38 | 17.38 |
| September | 3.17 | 1.25 | 5.85 | 2.30 | 4.56 | 1.80 | -0.87 | -0.34 | 2.16 | 0.85 | 17.16 | 17.16 |
| Total | 52.11 | 20.52 | 77.85 | 30.65 | 52.59 | 20.71 | -0.37 | -0.15 | 25.63 | 10.09 | | |

**Table 5-5. MIPSL Manhole 5 SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.01 | 1.19 | 4.17 | 1.64 | 3.34 | 1.31 | -0.99 | -0.39 | 1.82 | 0.72 | 17.00 | 17.00 |
| November | 3.10 | 1.22 | 4.18 | 1.65 | 2.43 | 0.96 | 0.12 | 0.05 | 1.62 | 0.64 | 17.03 | 17.03 |
| December | 3.24 | 1.28 | 6.48 | 2.55 | 1.82 | 0.72 | 2.98 | 1.17 | 1.67 | 0.66 | 17.79 | 17.79 |
| January | 4.84 | 1.91 | 6.95 | 2.74 | 2.13 | 0.84 | 2.98 | 1.17 | 1.85 | 0.73 | 18.55 | 18.55 |
| February | 4.90 | 1.93 | 6.56 | 2.58 | 3.65 | 1.44 | 0.87 | 0.34 | 2.04 | 0.80 | 18.77 | 18.77 |
| March | 5.57 | 2.19 | 7.74 | 3.05 | 5.17 | 2.04 | 0.25 | 0.10 | 2.33 | 0.92 | 18.83 | 18.83 |
| April | 4.00 | 1.57 | 5.84 | 2.30 | 5.47 | 2.15 | -1.99 | -0.78 | 2.35 | 0.93 | 18.33 | 18.33 |
| May | 3.82 | 1.50 | 6.71 | 2.64 | 5.78 | 2.28 | -1.49 | -0.59 | 2.42 | 0.95 | 17.95 | 17.95 |
| June | 5.68 | 2.24 | 7.32 | 2.88 | 6.08 | 2.39 | -1.24 | -0.49 | 2.48 | 0.98 | 17.63 | 17.63 |
| July | 5.11 | 2.01 | 8.11 | 3.19 | 6.38 | 2.51 | -0.74 | -0.29 | 2.47 | 0.97 | 17.44 | 17.44 |
| August | 5.68 | 2.24 | 7.94 | 3.13 | 5.78 | 2.28 | -0.25 | -0.10 | 2.42 | 0.95 | 17.38 | 17.38 |
| September | 3.17 | 1.25 | 5.85 | 2.30 | 4.56 | 1.80 | -0.87 | -0.34 | 2.16 | 0.85 | 17.16 | 17.16 |
| Total | 52.11 | 20.52 | 77.85 | 30.65 | 52.59 | 20.71 | -0.37 | -0.15 | 25.63 | 10.09 | | |

**Table 5-6. MIPSL Manhole 4A SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.21 | 1.26 | 4.17 | 1.64 | 3.34 | 1.31 | -0.87 | -0.34 | 1.70 | 0.67 | 17.21 | 17.21 |
| November | 3.21 | 1.26 | 4.07 | 1.60 | 2.43 | 0.96 | 0.12 | 0.05 | 1.51 | 0.59 | 17.24 | 17.24 |
| December | 3.33 | 1.31 | 6.22 | 2.45 | 1.82 | 0.72 | 2.85 | 1.12 | 1.55 | 0.61 | 17.97 | 17.97 |
| January | 5.06 | 1.99 | 6.81 | 2.68 | 2.13 | 0.84 | 2.98 | 1.17 | 1.70 | 0.67 | 18.72 | 18.72 |
| February | 4.98 | 1.96 | 6.26 | 2.46 | 3.65 | 1.44 | 0.74 | 0.29 | 1.87 | 0.74 | 18.91 | 18.91 |
| March | 5.78 | 2.28 | 7.55 | 2.97 | 5.17 | 2.04 | 0.25 | 0.10 | 2.13 | 0.84 | 18.97 | 18.97 |
| April | 4.11 | 1.62 | 5.65 | 2.22 | 5.47 | 2.15 | -1.98 | -0.78 | 2.16 | 0.85 | 18.47 | 18.47 |
| May | 4.04 | 1.59 | 6.65 | 2.62 | 5.78 | 2.28 | -1.36 | -0.54 | 2.24 | 0.88 | 18.12 | 18.12 |
| June | 5.88 | 2.31 | 7.13 | 2.81 | 6.08 | 2.39 | -1.24 | -0.49 | 2.29 | 0.90 | 17.81 | 17.81 |
| July | 5.21 | 2.05 | 7.79 | 3.07 | 6.38 | 2.51 | -0.87 | -0.34 | 2.27 | 0.89 | 17.59 | 17.59 |
| August | 5.87 | 2.31 | 7.75 | 3.05 | 5.78 | 2.28 | -0.25 | -0.10 | 2.22 | 0.87 | 17.52 | 17.52 |
| September | 3.27 | 1.29 | 5.68 | 2.24 | 4.56 | 1.80 | -0.87 | -0.34 | 1.99 | 0.78 | 17.30 | 17.30 |
| Total | 53.97 | 21.25 | 75.71 | 29.81 | 52.59 | 20.71 | -0.49 | -0.19 | 23.62 | 9.30 | | |

**Table 5-7. MIPSL Manhole 6A SESOIL Water Balance (Early Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.21 | 1.26 | 4.17 | 1.64 | 3.34 | 1.31 | -0.87 | -0.34 | 1.70 | 0.67 | 17.21 | 17.21 |
| November | 3.21 | 1.26 | 4.07 | 1.60 | 2.43 | 0.96 | 0.12 | 0.05 | 1.51 | 0.59 | 17.24 | 17.24 |
| December | 3.33 | 1.31 | 6.22 | 2.45 | 1.82 | 0.72 | 2.85 | 1.12 | 1.55 | 0.61 | 17.97 | 17.97 |
| January | 5.06 | 1.99 | 6.81 | 2.68 | 2.13 | 0.84 | 2.98 | 1.17 | 1.70 | 0.67 | 18.72 | 18.72 |
| February | 4.98 | 1.96 | 6.26 | 2.46 | 3.65 | 1.44 | 0.74 | 0.29 | 1.87 | 0.74 | 18.91 | 18.91 |
| March | 5.78 | 2.28 | 7.55 | 2.97 | 5.17 | 2.04 | 0.25 | 0.10 | 2.13 | 0.84 | 18.97 | 18.97 |
| April | 4.11 | 1.62 | 5.65 | 2.22 | 5.47 | 2.15 | -1.99 | -0.78 | 2.16 | 0.85 | 18.47 | 18.47 |
| May | 4.04 | 1.59 | 6.65 | 2.62 | 5.78 | 2.28 | -1.37 | -0.54 | 2.24 | 0.88 | 18.12 | 18.12 |
| June | 5.88 | 2.31 | 7.13 | 2.81 | 6.08 | 2.39 | -1.24 | -0.49 | 2.29 | 0.90 | 17.81 | 17.81 |
| July | 5.21 | 2.05 | 7.79 | 3.07 | 6.38 | 2.51 | -0.87 | -0.34 | 2.27 | 0.89 | 17.59 | 17.59 |
| August | 5.87 | 2.31 | 7.75 | 3.05 | 5.78 | 2.28 | -0.25 | -0.10 | 2.22 | 0.87 | 17.52 | 17.52 |
| September | 3.27 | 1.29 | 5.68 | 2.24 | 4.56 | 1.80 | -0.87 | -0.34 | 1.99 | 0.78 | 17.30 | 17.30 |
| Total | 53.97 | 21.25 | 75.71 | 29.81 | 52.59 | 20.71 | -0.50 | -0.20 | 23.62 | 9.30 | | |

## 6. SUMMARY OF MODEL SET-UP AND EARLY ACTION COMPUTATIONS

Following is a summary of methods and computations for each of the SESOIL models used for simulating the early action remedial activities. The results are summarized in Section 7.

### 321-M Early Action (Tube Cleaning Room/MIPSL Tie-in Area)

Recalculated CM RGOs for conditions following the early action. The model includes residual contamination below the excavation depth.

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-42 ft, k=$8.5x10^{-10}$ $cm^2$, (layer where 70% of soil volume removed and PCE mass remains), b) SCL 42-141 ft, k = $6.5x10^{-11}$ $cm^2$, contains residual PCE mass, c) CL 141-145 ft, k = $8.5x10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5x10^{-10}$ $cm^2$. *Note - for soil textures, SCL = sandy clay loam, CL = clay, LS = loamy sand.

2) Excavation footprint = 2,260 $ft^2$, excavation depth = 42 ft, 70% excavated, soil volume removed = 65,600 $ft^3$ (2,430 $yd^3$)

3) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 75 to account for 70% soil removal and installation of 'sand columns' in the voids.

4) PCE loaded into layer 1 (PCE concentration = 3 mg/kg in sublayers 8 to 10 for remaining PCE in the excavation) and into layer 2 (to simulate residual below the excavation = 2.4 mg/kg in sublayer 1, 0.15 mg/kg in sublayers 2 to 5 and 0.05 in sublayers 6 to 10 per data from MIPS-SB045 soil borings). Iterated upon the maximum PCE concentration in model layer 1, sublayers 8-10 that would not result in predicted groundwater concentrations greater than 5 μg/L.

Computations:

(SEVIEW filename = 321E21)
Early action CM RGO for PCE remaining in soil (based on 30% soil remaining in excavation 0-42 ft and residual detected from 42 ft to 141 ft) = 3 mg/kg. The maximum leachate concentration = 0.039 mg/L. The migration time to groundwater = 5.1 yrs, with maximum leachate time = 5.5 yrs. Almost all of PCE mass in soil (99%) removed via volatilization.

**320-M Early Action - MIPSL Tie-in Area**

Recalculated CM RGOs for conditions following the early action. It is expected that residual contamination will not exist below the excavation depth.

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-30 ft, k=$8.5 \times 10^{-10}$ $cm^2$, (layer where 70% of soil volume removed and TCE mass remains in remaining soil), b) SCL 30-141 ft, k = $6.5 \times 10^{-11}$ $cm^2$ (no TCE), c) CL 141-145 ft, k = $8.5 \times 10^{-12}$ $cm^2$ (no TCE), and d) LS 145-155 ft, k = $8.5 \times 10^{-10}$ $cm^2$ (no TCE).
2) Excavation footprint = 215 $ft^2$, excavation depth = 30 ft, 70% excavated, soil volume removed = 4,594 $ft^3$ (170 $yd^3$)
3) Increased the air diffusion coefficient for TCE (0.079 $cm^2$/sec) by a factor of 50 to account for 70% soil removal and installation of 'sand columns' in the voids.

4) TCE loaded into layer 1 (TCE concentration = 15 mg/kg in sublayers 8 to 10, data from MIPS-SB034 soil borings). Iterated upon the maximum TCE concentration in model layer 1 (sublayers 8-10) that would not result in predicted groundwater concentrations greater than 5 μg/L.

Computations:

(SEVIEW filename = 320T6)
Early action CM RGO for TCE remaining in soil (based on 30% soil remaining in excavation 0-30 ft) = 15 mg/kg. The maximum leachate concentration = 0.08 mg/L. The migration time to groundwater = 5 yrs with maximum leachate time = 11 yrs. Almost all of TCE mass in soil (99%) is removed via volatilization.

**320-M Early Action - Tube-Cleaning Pit Area Excavation**

Using the model assessed the contaminant load limit of PCE in soil after excavation (below 10 ft) that would not produce an exceedance of the MCL in groundwater. Next, tested PCE data (using M320-SB004 soil borings) from beneath the depth of the excavation to predict leachate and groundwater concentrations for soil left in-place.

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) LS 0-10 ft, k=$8.5 \times 10^{-10}$ $cm^2$, (layer where soil was removed and replaced with fill), b) SCL 10-141 ft, k = $6.5 \times 10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5 \times 10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5 \times 10^{-10}$ $cm^2$.
2) Excavation footprint = 150 $ft^2$
3) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 10 to account for contaminant placement near fill material.
4) Assumed residual PCE emplaced 10-23 ft bgs, in model layer 2, sublayer 1. Iterated upon PCE concentration that would not produce concentration in groundwater >5 μg/L.

5) Loaded PCE data from M320-SB004 soil borings (deeper than 10 ft bgs) and predicted concentration in groundwater.

Computations:

(SEVIEW filename = 320S17 for MCL determination, and 320S18 for simulation with soil boring data)
New CM RGO for PCE remaining in soil (based on early action) = 2.8 mg/kg. Using residual concentrations (from soil boring data), the maximum leachate concentration = 0.6 mg/L and predicted groundwater concentration is 0.3 μg/L (less than the MCL). The migration time to groundwater = 8.1 yrs with maximum leachate time = 17 yrs. 95% of the PCE mass in soil is removed via volatilization, while 4% removed via groundwater and <1% is removed via soil moisture.

**313M - Early Action - Core Cleaning Solvent Tank Pit Area Excavation**

Using the model assessed the contaminant load limit of PCE in soil after excavation (below 20 ft) that would not produce an exceedance of the MCL in groundwater. Next, tested PCE data (using 313M-003 soil borings) from beneath the depth of the excavation to predict leachate and groundwater concentrations for soil left in-place.

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) LS 0-20 ft, k=$8.5 \times 10^{-10}$ $cm^2$, (layer where soil was removed and replaced with fill), b) SCL 20-141 ft, k = $6.5 \times 10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5 \times 10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5 \times 10^{-10}$ $cm^2$.
2) Excavation footprint = 150 $ft^2$
3) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 10 to account for contaminant placement near fill material.
4) Assumed residual PCE emplaced below excavation depth (20-32 ft bgs, in sublayer 1 of model layer 2. Iterated upon the concentration limit that would not produce concentration in groundwater >5 μg/L.
5) Loaded PCE data from 313M-003 (soil borings deeper than 20 ft bgs) and predicted concentration in groundwater.

Computations:

(SEVIEW filename = 313S12 for MCL determination, and 313S13 for simulation with soil boring data)
New CM RGO for PCE remaining in soil (based on early action) = 1.8 mg/kg. Using residual concentration (from soil boring data), the maximum leachate concentration = 0.87 mg/L and predicted groundwater concentration is 23 μg/L (greater than the MCL). The migration time to groundwater = 7.1 yrs with maximum leachate time = 17 yrs. 81% of the PCE mass in soil is removed via volatilization, while 13% removed via groundwater, 3% removed via soil moisture and 2% via soil air.

**MIPSL Manhole 5 - No Early Action Planned**

Assuming that the maximum concentrations at MIPS-SB-030 soil borings apply to this site will contamination in soil cause exceedance of the MCL in groundwater?

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-20 ft, k=$6.5 \times 10^{-11}$ $cm^2$, (source layer), b) SCL 20-141 ft, k = $6.5 \times 10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5 \times 10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5 \times 10^{-10}$ $cm^2$.
2) Footprint = 215 $ft^2$
3) Since PCE>TCE, used PCE concentration data from MIPS-SB-030 soil borings, averaged for 0-2 ft (0.15 mg/kg), 3-5 ft (0.05 mg/kg), 8-10 ft (0.43 mg/kg), and 18-20 ft (1.0 mg/kg) intervals.
4) A normal air diffusion coefficient for PCE (0.072 $cm^2$/sec) was used for this calculation.

Computations:

(SEVIEW filename = 313MP7)

Based on the modeled conditions, the maximum leachate concentration = 0.1 mg/L. The migration time to groundwater = 31 yrs with maximum leachate time = 34 yrs. 46% of the PCE mass in soil is removed via volatilization, while 25% removed via groundwater, 14% removed via soil moisture, 12% via soil air and 3% adsorbed. The predicted maximum concentration in groundwater is 4 μg/L

**MIPSL Manhole 4A - No Early Action Planned**

Assuming that the maximum concentrations at MIPS-SB-015 soil borings apply to this site will contamination in soil cause exceedance of the MCL in groundwater?

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-20 ft, k=$6.5x10^{-11}$ $cm^2$, (source layer), b) SCL 20-141 ft, k = $6.5x10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5x10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5x10^{-10}$ $cm^2$.
2) Footprint = 15 ft x 15 ft = 225 $ft^2$
3) Since PCE>TCE, used PCE concentration data from MIPS-SB-015 soil borings, averaged for 0-2 ft (0.003 mg/kg), 3-5 ft (0.007 mg/kg), 8-10 ft (0.14 mg/kg), and 18-20 ft (2.0 mg/kg) intervals.
4) A normal air diffusion coefficient for PCE (0.072 $cm^2$/sec) was used for this calculation.

Computations:

(SEVIEW filename = MP4A3)
Based on the modeled conditions, the maximum leachate concentration = 0.16 mg/L. The migration time to groundwater = 31 yrs with maximum leachate time = 33 yrs. 36% of the PCE mass in soil is removed via volatilization, while 30% removed via groundwater, 16% removed via soil moisture, 14% via soil air and 3% adsorbed. The predicted maximum concentration in groundwater is 5 μg/L.

**MIPSL Manhole 6A - No Early Action Planned**

Assuming that the maximum concentrations at MIPS-SB-009 soil borings apply to this site, will contamination in soil cause exceedance of the MCL in groundwater?

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-20 ft, k=$6.5x10^{-11}$ $cm^2$, (source layer), b) SCL 20-141 ft, k = $6.5x10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5x10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5x10^{-10}$ $cm^2$.
2) Footprint = 10 ft x 15 ft = 150 $ft^2$
3) Since PCE>TCE, used PCE concentration data from MIPS-SB-009 soil borings, averaged for 0-2 ft (0.138 mg/kg), 3-5 ft (0.291 mg/kg), 8-10 ft (1.1 mg/kg), and 18-20 ft (0.123 mg/kg) intervals.
4) A normal air diffusion coefficient for PCE (0.072 $cm^2$/sec) was used for this calculation.

Computations:

(SEVIEW filename = MP6A3)
Based on the modeled conditions, the maximum leachate concentration = 0.07 mg/L. The migration time to groundwater = 31 yrs with maximum leachate time = 34 yrs. 63% of the PCE mass in soil is removed via volatilization, while 17% removed via groundwater, 9% removed via soil moisture, 8% via soil air and 2% adsorbed. The predicted maximum concentration in groundwater is 1 μg/L.

## 7. SUMMARY OF EARLY ACTION MODEL PREDICTIONS

The SESOIL modeling results, including predicted PCE/TCE contaminant mass, percent phase distributions, maximum leachate concentrations and contaminant mass fate plots are presented in Figures 7-1 to 7-9. The modeling results are summarized below in Tables 7-1 and 7-2. The modeling results consider the expected post removal action conditions (residual contaminant mass and contaminant thickness). The recalculated early action CM RGOs are listed in Table 7-1.

**Table 7-1. Modeling Results for Early Actions**

| Facility | Contaminant Modeled | Early Action | Iterate to CM RGO Concentration in Soil or Use Soil Boring Data? | Recalculated Early Action CM RGO |
|---|---|---|---|---|
| 321-M Tube Cleaning Room/MIPSL Tie-in Area | PCE | 70% Soil Removal (0-42 ft bgs) and Backfill in Sand Columns - Residual PCE Beneath Excavation | Both – Iterate to Maximum PCE Conc. (in 30% Remaining Soil plus Residual PCE from Soil Boring Data) Resulting in Groundwater < MCL | 3 mg/kg |
| 320-M MIPSL Tie-in Area | TCE | 70% Soil Removal (0-30 ft bgs) and Backfill in Sand Columns - No Residual TCE Beneath Excavation | Iterate to Maximum TCE Conc. (in 30% Remaining Soil) Resulting in Groundwater < MCL | 15 mg/kg |
| 320-M Tube Cleaning Pit Area | PCE | 100% Soil Removal (0-10 ft bgs) and Backfill | Both - Iterate to Maximum PCE Conc. (in Soil Beneath Excavation) Resulting in Groundwater < MCL, and Use Soil Boring Data and Test if Predicted PCE Groundwater Conc. < MCL, Results are below In Table 7-2 | 2.8 mg/kg |
| 313-M Core Cleaning Solvent Tank Pit Area | PCE | 100% Soil Removal (0-20 ft bgs) and Backfill | Both - Iterate to Maximum PCE Conc. (in Soil Beneath Excavation) Resulting in Groundwater < MCL, and Use Soil Boring Data and Test if Predicted PCE Groundwater Conc. < MCL, Results are below in Table 7-2 | 1.8 mg/kg |

**Table 7-2. Modeling Results for MIPSL Sites and MAOU Facilities using Soil Boring Data**

| Facility | Contaminant Modeled | Representative Soil Borings | Predict Impact to Groundwater >MCL? |
|---|---|---|---|
| 321-M Tube Cleaning Room/MIPSL Tie-in Area | PCE | MIPS-SB045 (Residual PCE > 42 ft bgs)[1] | No, < 5 µg/L |
| MIPSL Manhole 5 | PCE | MIPS-SB030 | No, Maximum Predicted PCE in Groundwater = 4 µg/L |
| MIPSL Manhole 4A | PCE | MIPS-SB015 | Yes, Maximum Predicted PCE in Groundwater = 5 µg/L |
| MIPSL Manhole 6A | PCE | MIPS-SB009 | No, Maximum Predicted PCE in Groundwater = 1 µg/L |
| 320-M Tube Cleaning Pit Area | PCE | M320-SB-004 (Data Below Excavation) | No, Maximum Predicted PCE in Groundwater = 0.3 µg/L |
| 313-M Core Cleaning Solvent Tank Pit Area | PCE | 313M-003 (Data Below Excavation) | Yes, Maximum Predicted PCE in Groundwater = 23 µg/L |

[1]Model contaminant load includes residual PCE in excavation (30-42 ft bgs) plus residual PCE > 42 ft bgs (MIPS-SB045 soil borings).

**SESOIL Output File:** C:\SEVIEW62\321E21.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 6.714E+09 | 99.90 |
| In Soil Air | 2.604E+00 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 5.707E-01 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 2.767E+00 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 4.903E+06 | 0.07 |
| Total Output | 6.719E+09 | 99.98 |
| Total Input | 6.721E+09 | |
| Input - Output | 1.539E+06 | |

**Maximum leachate concentration:** 3.875E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 4210.00 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

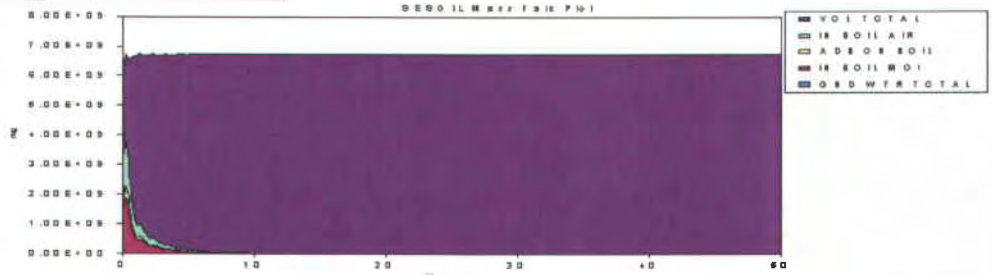


Figure 7-1. 321-M SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the CM RGO Recalculation

**SESOIL Output File:** C:\SEVIEW62\320T6.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.230E+09 | 99.73 |
| In Soil Air | 3.440E+03 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 1.866E+03 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 8.514E+03 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 3.179E+06 | 0.26 |
| Total Output | 1.233E+09 | 99.99 |
| Total Input | 1.234E+09 | |
| Input - Output | 1.835E+05 | |

**Maximum leachate concentration:** 8.454E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Trichloroethylene (TCE)
C:\SEVIEW62\TCE.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 958.20 **cm**
**Ending Depth:** 4721.00 **cm**
**Total Depth:** 4721.00 **cm**


Figure 7-2. 320-M MIPSL Tie-in SESOIL Modeling Results, Predicted TCE Mass and Phase Distribution for the CM RGO Recalculation

**SESOIL Output File:** C:\SEVIEW62\320S17.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 2.276E+08 | 97.04 |
| In Soil Air | 7.856E+05 | 0.33 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 1.759E+05 | 0.07 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 8.684E+05 | 0.37 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 5.037E+06 | 2.15 |
| Total Output | 2.345E+08 | 99.96 |
| Total Input | 2.346E+08 | |
| Input - Output | 8.462E+04 | |

**Maximum leachate concentration:** 8.849E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 582.20 **cm**
**Ending Depth:** 4722.00 **cm**
**Total Depth:** 4722.00 **cm**

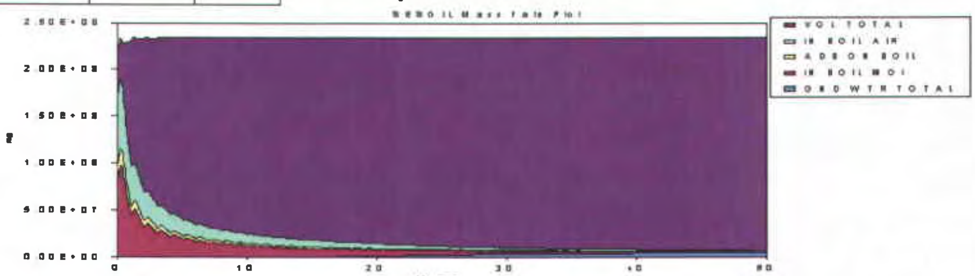


**Figure 7-3. 320-M Tube Cleaning Pit SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the CM RGO Recalculation**

**SESOIL Output File:** C:\SEVIEW62\320S18.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 4.227E+07 | 94.70 |
| In Soil Air | 2.380E+05 | 0.53 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 5.330E+04 | 0.12 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 2.631E+05 | 0.59 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 1.786E+06 | 4.00 |
| Total Output | 4.461E+07 | 99.95 |
| Total Input | 4.464E+07 | |
| Input - Output | 2.430E+04 | |

**Maximum leachate concentration:** 2.969E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 3774.00 **cm**
**Ending Depth:** 4722.00 **cm**
**Total Depth:** 4722.00 **cm**

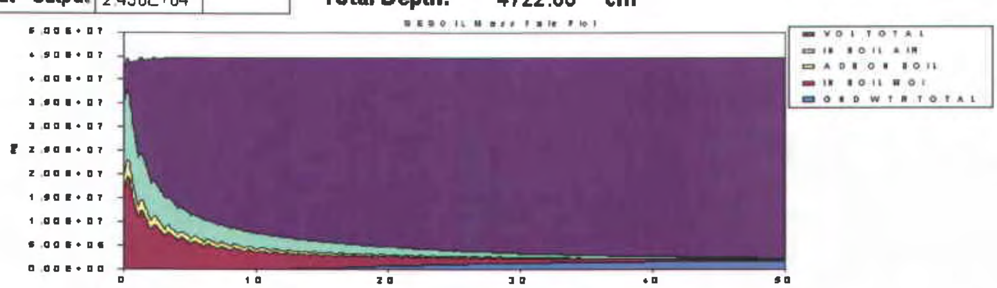


**Figure 7-4. 320-M Tube Cleaning Pit SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution using Soil Boring Data**

**SESOIL Output File:** C:\SEVIEW62\313S13.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 3.881E+08 | 81.01 |
| In Soil Air | 1.276E+07 | 2.66 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 2.846E+06 | 0.59 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 1.400E+07 | 2.92 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 6.070E+07 | 12.67 |
| Total Output | 4.785E+08 | 99.85 |
| Total Input | 4.792E+08 | |
| Input - Output | 6.978E+05 | |

**Maximum leachate concentration:** 8.701E-01 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 3819.00 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

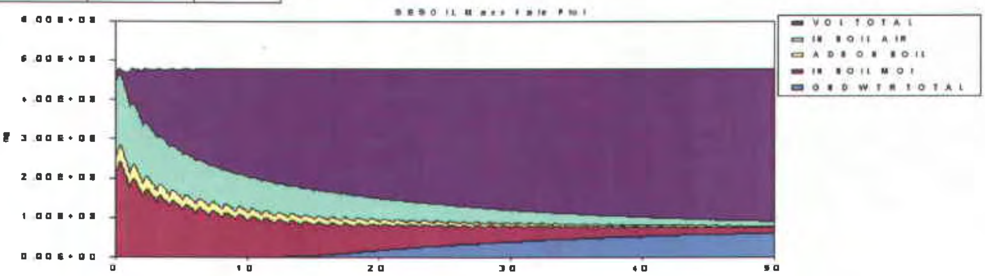

**Figure 7-5. 313-M SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the CM RGO Recalculation**

**SESOIL Output File:** C:\SEVIEW62\313S12.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.202E+08 | 86.17 |
| In Soil Air | 2.830E+06 | 2.03 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 6.311E+05 | 0.45 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 3.105E+06 | 2.23 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 1.251E+07 | 8.97 |
| Total Output | 1.392E+08 | 99.85 |
| Total Input | 1.395E+08 | |
| Input - Output | 2.096E+05 | |

**Maximum leachate concentration:** 1.820E-01 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 867.20 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

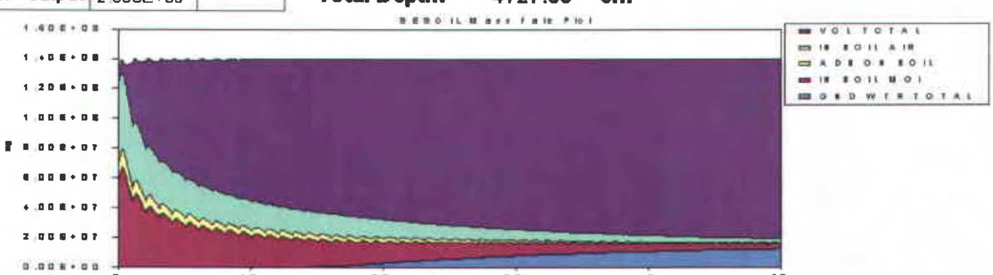

**Figure 7-6. 313-M SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution using Soil Boring Data**

**SESOIL Output File:** C:\SEVIEW62\313MP7.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.377E+07 | 46.12 |
| In Soil Air | 3.637E+06 | 12.18 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 8.194E+05 | 2.74 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 4.065E+06 | 13.61 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 7.510E+06 | 25.14 |
| Total Output | 2.981E+07 | 99.80 |
| Total Input | 2.987E+07 | |
| Input - Output | 5.979E+04 | |

**Maximum leachate concentration:** 9.932E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 590.70 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

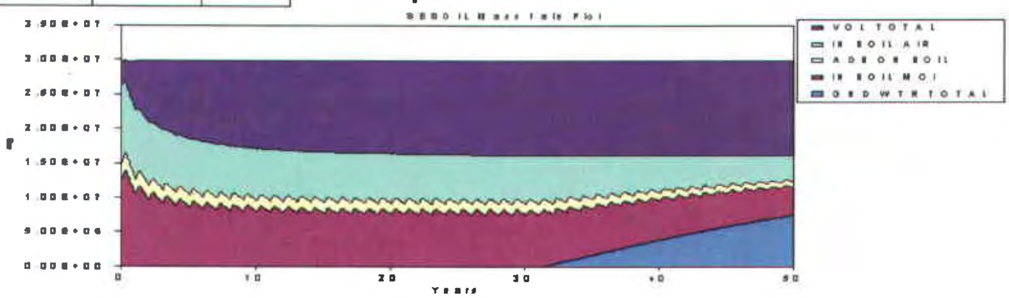


**Figure 7-7. MIPSL Manhole 5 SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution using Soil Boring Data**

**SESOIL Output File:** C:\SEVIEW62\MP4A3.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.474E+07 | 35.79 |
| In Soil Air | 5.975E+06 | 14.50 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 1.346E+06 | 3.27 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 6.679E+06 | 16.21 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 1.233E+07 | 29.94 |
| Total Output | 4.108E+07 | 99.70 |
| Total Input | 4.121E+07 | |
| Input - Output | 1.217E+05 | |

**Maximum leachate concentration:** 1.562E-01 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 590.70 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

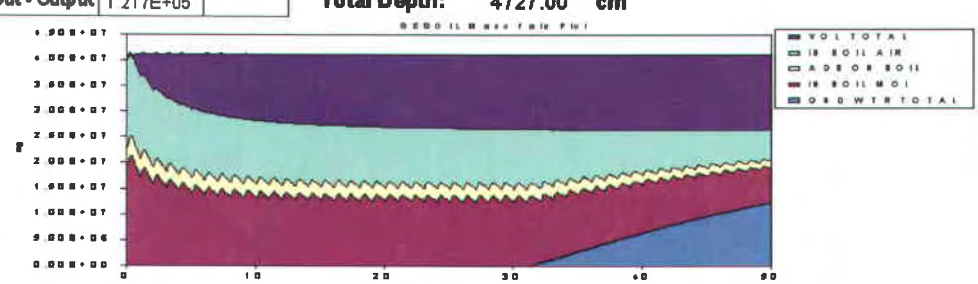


**Figure 7-8. MIPSL Manhole 4A SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution using Soil Boring Data**

**SESOIL Output File:** C:\SEVIEW62\MP6A3.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.329E+07 | 62.82 |
| In Soil Air | 1.779E+06 | 8.41 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 4.007E+05 | 1.89 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 1.988E+06 | 9.40 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 3.674E+06 | 17.36 |
| Total Output | 2.113E+07 | 99.89 |
| Total Input | 2.116E+07 | |
| Input - Output | 2.409E+04 | |

**Maximum leachate concentration:** 6.943E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 590.70 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

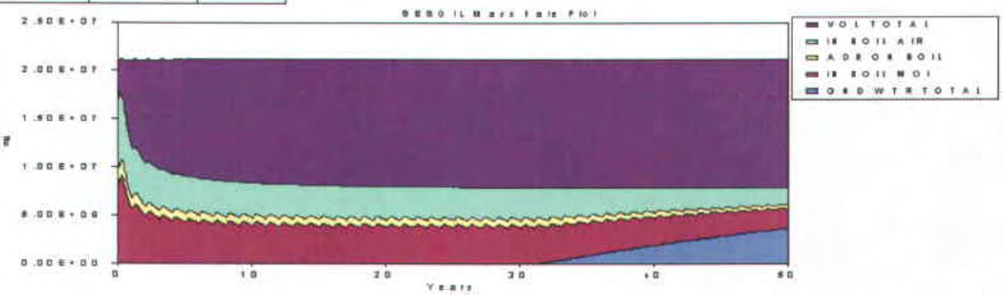


**Figure 7-9. MIPSL Manhole 6A SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution using Soil Boring Data**

## 8. SUMMARY OF MAOU REMEDIAL ACTIONS AND CONTAMINANT LEVELS DURING AND AFTER EARLY ACTIONS

A status of the MAOU facilities undergoing early action (either completed, in progress or planned) is presented in Table 8-1. The identified early actions involve the following MAOU Salvage Yard and Production Area facilities: 1) 741-A, 2) 341-1M, 3) 341-8M, 4) 322-M, 5) 321-M, 6) 320-M, and 7) 313-M. Also, Table 8-1 lists the expected conditions after early actions are completed.

A list of the Production Area facilities that are likely to undergo final action and the problems warranting action are provided in Table 8-2. These facilities include:

- 321-M Tube Cleaning Room area (PCE in 30% remaining soil in the excavation, beneath the excavation, and stockpiled soil <50 mg/kg PCE placed in the top of the excavation)
- 320-M MIPSL Tie-in area (TCE in 30% remaining soil in the excavation)
- 313-M Core Cleaning Solvent Tank Pit Area (PCE remaining beneath the excavation), and
- MIPSL Manhole 4A (PCE in soil).

For each of the facilities where either an early action has been completed, planned or is in progress (or only a final action is planned), following is a discussion of the contamination and contaminant levels prior to the early action (if applicable) and the expected contamination afterwards. Since the modeling calculations in this Appendix B are for VOCs in soil, the contaminant distribution discussion below focuses mainly on the extent of PCE/TCE contamination in soil.

<u>741-A Salvage Yard</u>

The Salvage Yard was used for storage of construction materials and used transformers. The RAO for the 741-A Salvage Yard early action was to prevent human exposure to contaminants present in the surface soil/gravel (arsenic, Arochlor 1254, Arochlor 1260, benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene) that may present risk to a future industrial worker greater than 1E-06. The early action has been completed and the contamination area removed is shown in Figure 8-1.

During early action, the surface soil/gravel was excavated to a depth of two feet and transported to the A-Area Ash Pile for use as nonstructural fill. The early action is complete and constitutes the final action for the 741-A Salvage Yard. At this time, the contaminant levels (if any) remaining is not expected to produce a further problem warranting action.

341-1M and 341-8M

These buildings were associated with the Liquid Effluent Treatment Facilities, where Building 341-1M was the Interim Treatment and Storage Facility and 341-8M was the Vendor Treatment Facility. The RAO for both 341-1M and 341-8M was to prevent human exposure to surficial radiological contaminants (U-235/U-238) present on the concrete slab surface that may present a risk to a future industrial worker greater than 1E-06. The location of U-235/U-238 fixed contamination spots on the concrete slabs at 341-1M (one spot) and 341-8M (two spots) are shown in Figures 8-2 and 8-3, respectively. These spots are indicated on the maps as 'ISOCS Samples >1.9 pCi/g (PRG)'. The U-235/U-238 contamination spots on the concrete slabs at 341-1M and 341-8M will be addressed during early actions.

322-M

Building 322-M was the Metallurgical Laboratory. No solvents were used at 322-M, but solvent contamination at 322-M was addressed under the MIPSL OU. A problem warranting action that has been addressed during early action includes PTSM removal (U-238, R-226 and K-40 in concrete sumps, and U-235 and U-238 in the MIPSL pipeline sludge). The remaining RAO includes HH issues related to the fixed radiological contamination (U-235/U-238) on the concrete slab surface. Figure 8-4 shows the removal areas (purple hachure area) where radiologically contaminated MIPSL pipeline/sludge was removed. The extent of the radiologically contaminated concrete slab (blue hachure area) where fixed contamination spots exist is shown in Figure 8-5. The fixed U-235/U-238 contamination on the concrete slab will be addressed during early actions.

321-M

The problems warranting action for the 321-M Fuel Fabrication Facility include: 1) fixed radiological contamination (U-235) on the concrete slab (PTSM and HH issues) and 2) PCE in soil beneath the Tube Cleaning Room (PTSM and CM issues). These problems will be addressed as early actions. After early action, the remaining problems will include residual PCE in soil in the excavated area beneath the Tube Cleaning Room (where 70% of the soil will be removed to a depth of 42 feet during early action), in stockpiled soil (>PRG and <50 mg/kg PCE), and residual contamination in soil deeper than 42 feet (CM issue).

*Description of Early Actions*

The early action at 321-M involves soil removal from beneath the pipe tie-in area west of 321-M and the Tube Cleaning Room. Figure 8-6 shows the concrete slab areas already removed during early action and VOC contaminated concrete and soil removal areas. During early action, 70% of the soil will be removed from the area shown in Figure 8-6 using a large-diameter foundation auger. The soil will be excavated to a depth of 42 ft and the planned auger removal pattern is shown in Figure 8-7. Note that the entire volume of soil beneath the area will be treated by removal or through the final action. During excavation the soil will be segregated into piles according to contaminant levels. The soil with PCE concentration >PRG and <50 mg/kg (the significant source concentration cutoff) will be stockpiled and then treated during the final action. The handling of the non-contaminated soil and contaminated soil >50 mg/kg PCE is discussed in the MAOU Production Area RSER/EE/CA (WSRC 2006a). Note that MIPSL Manhole 4A is also identified as a 'VOC Contamination Soil > CMRGO' in Figure 8-7, but this area is addressed separately from 321-M (see 'MIPSL Manhole 4A' below).

*Description of Final Actions*

The final action for 321-M Tube Cleaning Room area includes returning the excavated soil with PCE >PRG and <50 mg/kg to the top of the excavated area (including (>PRG and <significant source soil from excavation of 320-M, too) and installation of a horizontal PSVE treatment system in the soil. The footprint of the treatment area may be enlarged when the stockpiled soil is in place for the final action. The volume of soil that will be stockpiled is not known at this time. A schematic diagram showing the early action excavation and configuration of the final action remedy is provided in Figure 8-8. Infiltration control from precipitation events and soil vapor collection will be enhanced by the installation of a low-permeability geosynthetic cover over the excavated area. The final action addresses residual PCE in the >PRG and <significant source soil, the 30% remaining soil in-place and from beneath the excavation depth.

*PCE Concentration Levels*

Since the pipe tie-in area west of 321-M and Tube Cleaning Room areas were identified as primary sources of VOC contamination in soil at 321-M, the MAOU remedial investigation characterization efforts were focused in these areas (WSRC 2007a). The maximum PCE concentrations detected in soil are 12,300 mg/kg (8-10 ft below the pipe tie-in) and 11,400 mg/kg (18-20 ft below the pit in the Tube Cleaning Room. The majority of PCE concentrations detected are less than 1 mg/kg, except for the samples collected beneath the pipe tie-in and Tube Cleaning Room pit areas.

Figure 8-9 is a schematic cross section at 321-M that shows PCE concentrations from soil boring data. As the figure shows, the highest PCE concentrations are in the excavation area where 70% of the soil will be removed. During early action, clean sand will be installed in the voids and there will be two to three feet of native soil left between the sand columns. As shown in the figure, the contaminants in soil beneath the Tube Cleaning Room extend deeper than the Upland Unit and into the Tobacco Road Formation. From MIPS-SB45 soil borings, minor residual PCE will exist beneath the excavation in the Tobacco Road Formation (maximum PCE concentration = 2,460 μg/kg). The Tobacco Road Formation consists of moderately-sorted sand that is more permeable than the silty clay/clayey silt strata of the Upland Unit. Calculations for the CM analysis (final action) at 321-M and the estimated PSVE removal rate for PCE are provided in Section 9.

<u>320-M</u>

The problems warranting action for the 320-M Alloy Building that are being addressed under early actions include TCE in soil beneath the MIPSL tie-in area and the brick/concrete base of the Tube Cleaning Pit and soil (both areas had significant source material for VOC contamination). After the early action soil excavation, the remaining problem includes residual VOCs in soil at the MIPSL tie-in area (significant source and CM issues).

*Description of Early Actions*

The early action at 320-M involves soil removal from beneath the MIPSL tie-in area (same approach as the 321-M early action except that the excavation footprint is much smaller and depth = 30 ft bgs). Figure 8-10 shows the planned soil removal area. During early action, 70% of the soil will be removed using a large-diameter foundation auger. Note that the entire volume of soil beneath the area will be treated by removal or through the final action. The soil will be segregated into soil piles according to contaminant levels. The soil with detected TCE concentration >PRG and <50 mg/kg will be stockpiled and then treated during the final action at 321-M. The handling of the non-contaminated soil and contaminated soil >50 mg/kg TCE is discussed in the MAOU Production Area RSER/EE/CA (WSRC 2006a).

*Description of Final Actions*

The final action for the MIPSL tie-in area includes PSVE treatment of the soil and induced volatilization of VOCs in the 30% remaining soil in-place. In addition, a PSVE system will be installed to treat the soil remaining after the early action. The area to be treated under the final action is the same area shown in Figure 8-10.

*TCE Concentration Levels*

Figure 8-11 is a schematic cross section that shows TCE concentrations from soil borings in and near the MIPSL tie-in area. The data show that the highest TCE concentrations are present near the base of the planned excavation (maximum = 110,000 μg/kg), and excavation removes the highest concentrations of TCE. The residual TCE contamination will be addressed by PSVE. Calculations for the CM analysis (final action) at 320-M and the estimated PSVE removal rate for PCE are provided in Section 9.

313-M

The problems warranting action for the 313-M Slug Production Facility that are addressed under early actions include; 1) removal of fixed radiological contamination (U-235 and U-238) on concrete slabs (HH issue), 2) removal of radiological contamination in the Core Recovery Room sumps and soil (HH and PTSM), 3) removal of radiological contamination in the Autoclave sump, trenches and soil (HH and PTSM), and 4) removal of PCE in soil beneath the Core Cleaning Room Solvent Tank Pit and soil (significant source and CM issue). After early action, (including excavation of the soil to 20 ft and backfill with clean soil at the Core Cleaning Room Solvent Tank Pit), the remaining problem is residual PCE in soil beneath the pit excavation (CM issue). Figure 8-12 shows the fixed radiological contamination on concrete slabs >PRGs (purple hachured areas) that will be addressed under early actions and the residual PCE in soil at the Core Cleaning Room Solvent Tank Pit area that will be addressed during final actions.

The Core Cleaning Solvent Tank Pit is the primary source of VOC contamination in soil at 313-M (WSRC 2007a). Soil beneath the Core Cleaning Solvent Tank Pit contains PCE concentrations that range from 0.0015 to 62.1 mg/kg, with the maximum concentrations occurring 12 ft bgs. Elevated PCE concentrations above the post-early action CM RGO (1.8 mg/kg) were detected from the ground surface to 50 ft bgs. In deeper soil, PCE was detected at low concentrations but remain below this CM RGO.

Figure 8-13 shows PCE concentrations in soil and the excavated area beneath the Core Cleaning Room Solvent Tank Pit. The maximum PCE concentration is 62,100 µg/kg at a depth of 12 ft, but the highest concentrations and bulk of contamination was removed during the early action. The final action for the residual PCE remaining in soil includes installation of a PSVE well (footprint = 150 $ft^2$). The CM analysis for the final action addressing residual PCE in soil and the estimated PSVE removal rate area are provided in Section 9.

MIPSL Manhole 4A

The location of MIPSL Manhole 4A is shown in Figure 8-7 (by 321-M). From the CM calculations for MIPSL Manhole 4A (see Section 7 above), it was determined that PCE may be a CM issue. The calculations included PCE concentration data from MIPS-SB-015 soil borings (close to MIPSL Manhole 4A). The maximum PCE concentration in this soil boring is 2 mg/kg (18-20 ft bgs).

As a result of the potential for a CM issue at MIPSL Manhole 4A, a final action is planned. The final action includes the installation of a PSVE well in this ~225 $ft^2$ area. The CM analysis calculations for the final action and the estimated PSVE removal rate for PCE are provided in Section 9.

**Table 8-1. Early Action/Post-Early Action Status**

| Facility | Early Action? | Early Action Activity | Status of Early Action | Post-Early Action Status | |
|---|---|---|---|---|---|
| | | | | Will PTSM or Significant Source (PCE/TCE >50 mg/kg) Remain? | Will CM COCs Remain? |
| 741-A | Yes | Removal of contaminated surface soil/gravel (arsenic, PCBs, PAHs) The early action is also considered the final action for 741-A. | Complete | No | No |
| 341-1M | Yes | Removal of radiological contaminants (U-235, U-238) at locations on the concrete slab surface that may present a risk greater than 1E-06 to a future industrial worker | Planned | No | No |
| 341-8M | Yes | Removal of radiological contaminants (U-235, U-238) at locations on the concrete slab surface that may present a risk greater than 1E-06 to a future industrial worker | Planned | No | No |
| 322-M | Yes | Removal of radiological contamination – concrete slab, pipe and soil. Radiological contaminants (U-235, U-238) at locations on the concrete slab surface may present a risk greater than 1E-06 to a future industrial worker | Complete for Pipe ad Soil, Planned for Concrete Slab | No | No |
| 321-M | Yes | Removal of radiological contamination - Machining/Casting Room concrete slabs | Complete | No | No |
| | Yes | Removal of significant source VOCs >50 mg/kg - Tube Cleaning Room sumps/soil (70% of soil removed) | In Progress | Yes, in the 30% of the soil remaining in the excavated area | Yes |
| 320-M | Yes | Removal of significant source VOCs >50 mg/kg - Tube Cleaning Pit and soil | Complete | No | No |
| | Yes | Removal of significant source VOCs >50 mg/kg - soil at MIPSL Tie-in area (70% of soil removed) | In Progress | Yes, in the 30% of the soil remaining in the excavated area | Yes |
| 313-M | Yes | Removal of radiological contamination - Core Recovery Room sumps/soil | Complete | No | No |
| | Yes | Removal of radiological contamination - Autoclave sump/trenches/soil | Complete | No | No |
| | Yes | Radiological contaminants (U-235, U-238) at locations on the concrete slab surface may present a risk greater than 1E-06 to a future industrial worker | Planned | No | No |
| | Yes | Removal of significant source VOCs >50 mg/kg - Core Cleaning Solvent Tank Pit and soil | Complete | No | Yes |

**Table 8-2. Final Action Summary**

| Facility | Problem Warranting Action | Final Action Planned? |
|---|---|---|
| 321-M | Following early action at the Tube Cleaning Room area, residual PCE may be present in the 30% remaining soil, surface stockpiled soil and soil deeper than the excavation (> 42 ft bgs) at concentrations that impact groundwater above MCLs | Yes |
| | Following early action, residual PCE may be present in surface stockpiled soil at a risk greater than 1E-06 for a future industrial worker | Yes |
| 320-M | Following early action at the MIPSL Tie-in area, residual TCE may be present in the 30% remaining soil at concentrations that impact groundwater above MCLs | Yes |
| 313-M | Following early action, PCE may be present in soil at concentrations that impact groundwater above MCLs beneath the Core Cleaning Solvent Tank Pit | Yes |
| MIPSL Manhole 4A (near 321-M) | PCE may be present in soil at concentrations that impact groundwater above MCLs | Yes |

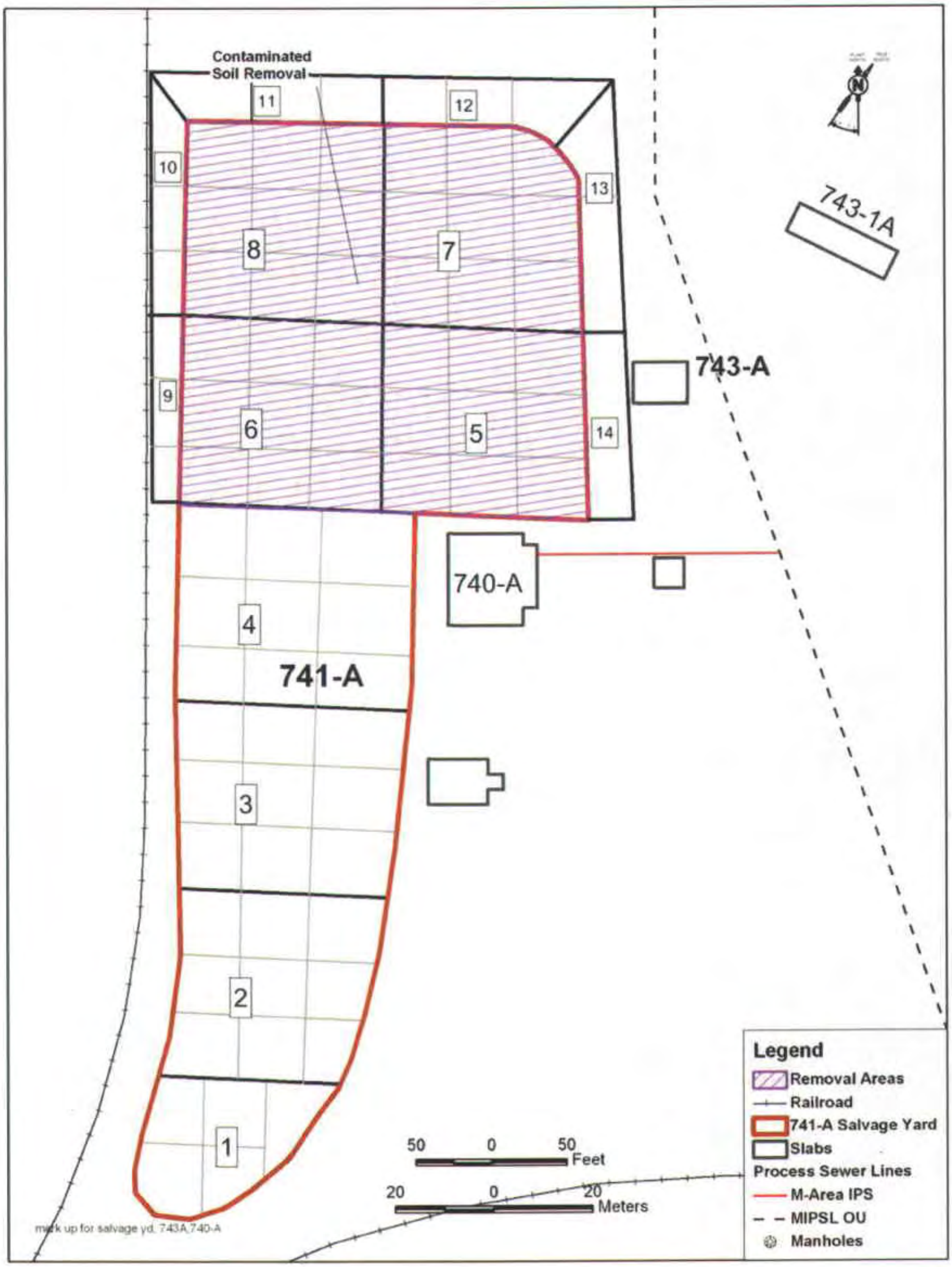


**Figure 8-1. Salvage Yard Problem Area for Early Action, Status = Completed**

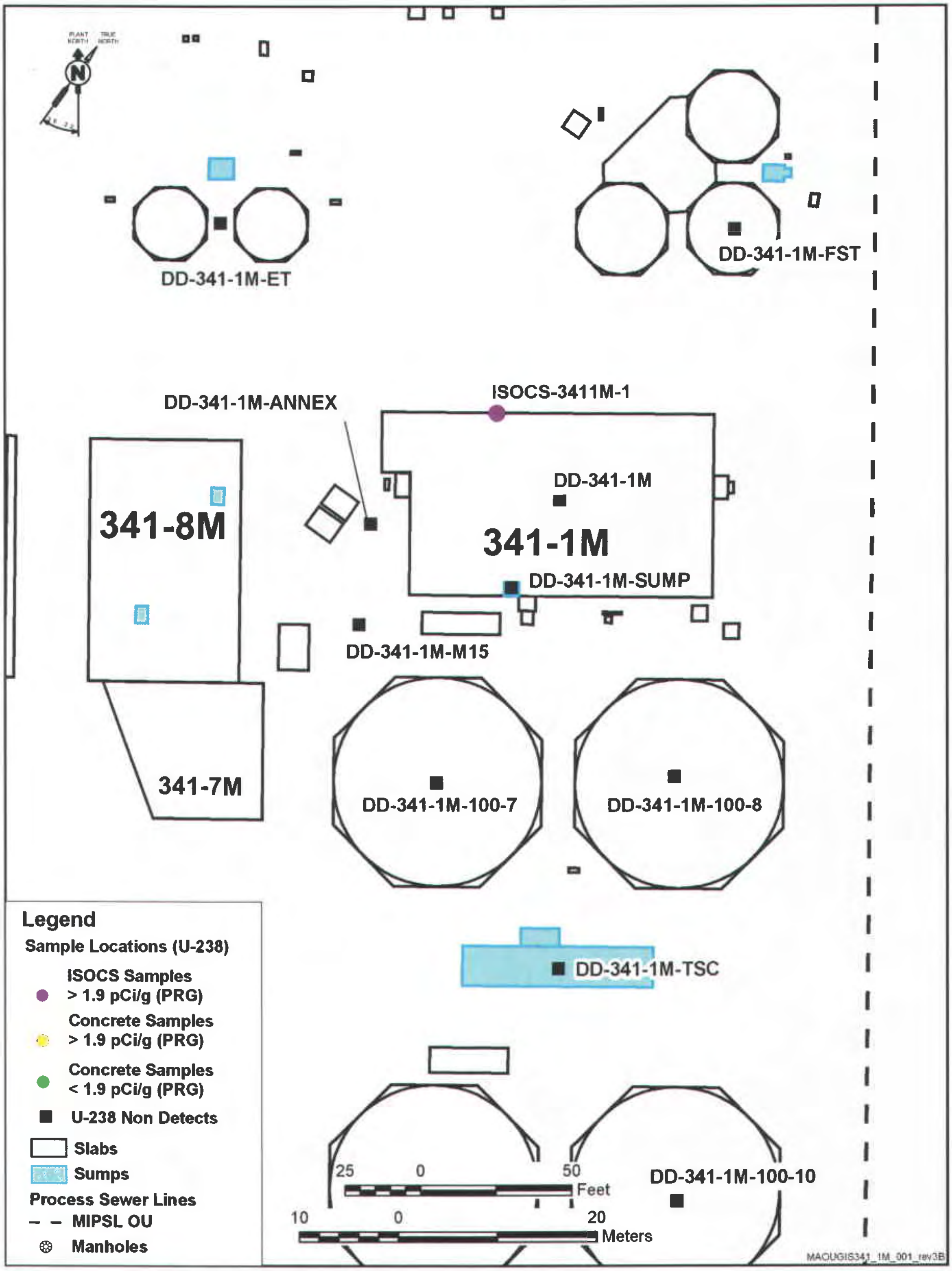


Figure 8-2. 341-1M U-238 in Concrete Slab - Comparison to PRG Threshold - Area to be Addressed Under Early Action

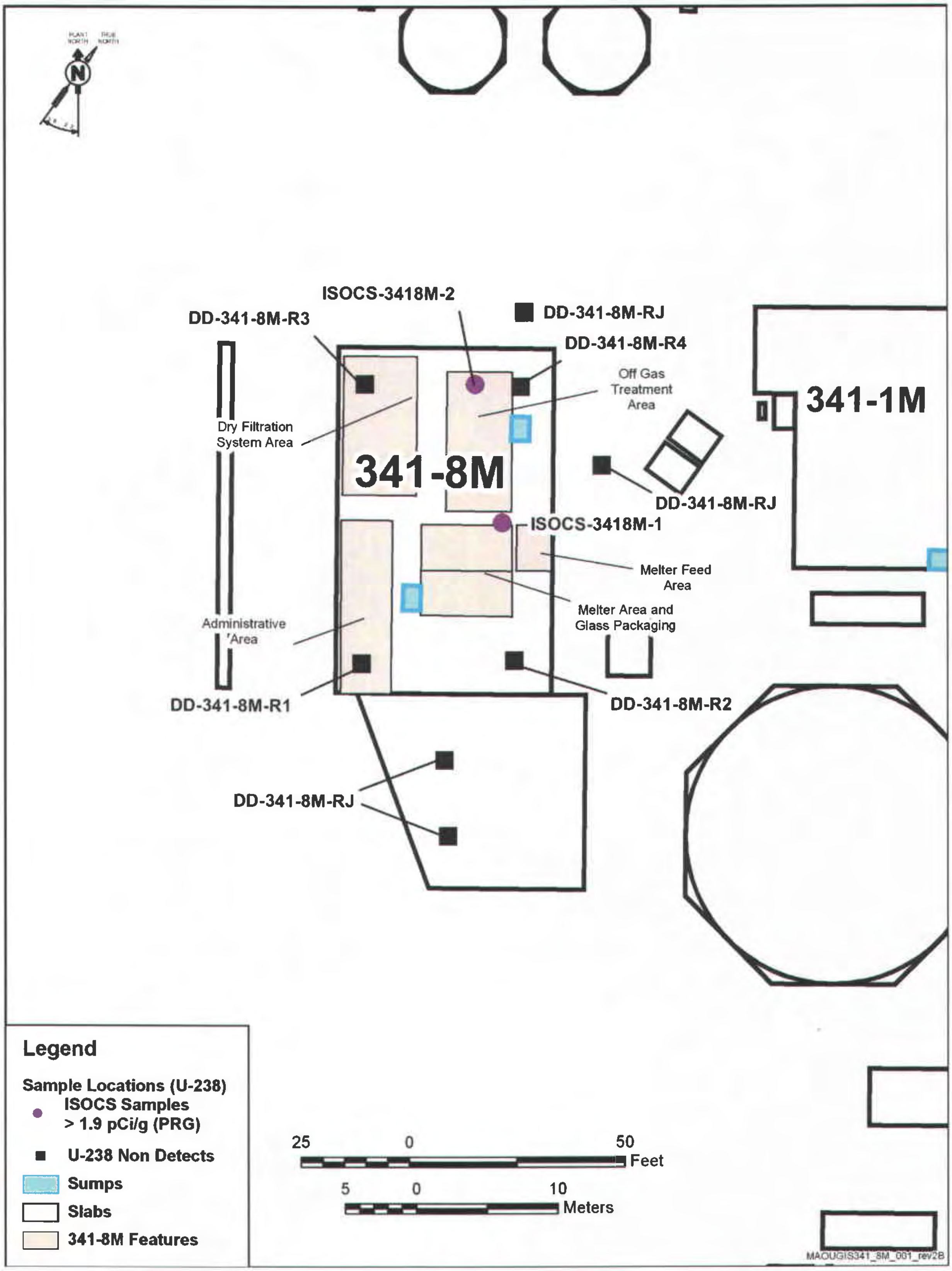


Figure 8-3. 341-8M U-238 Concentration in Concrete Slab - Comparison to PRG Threshold - Area to be Addressed Under Early Action

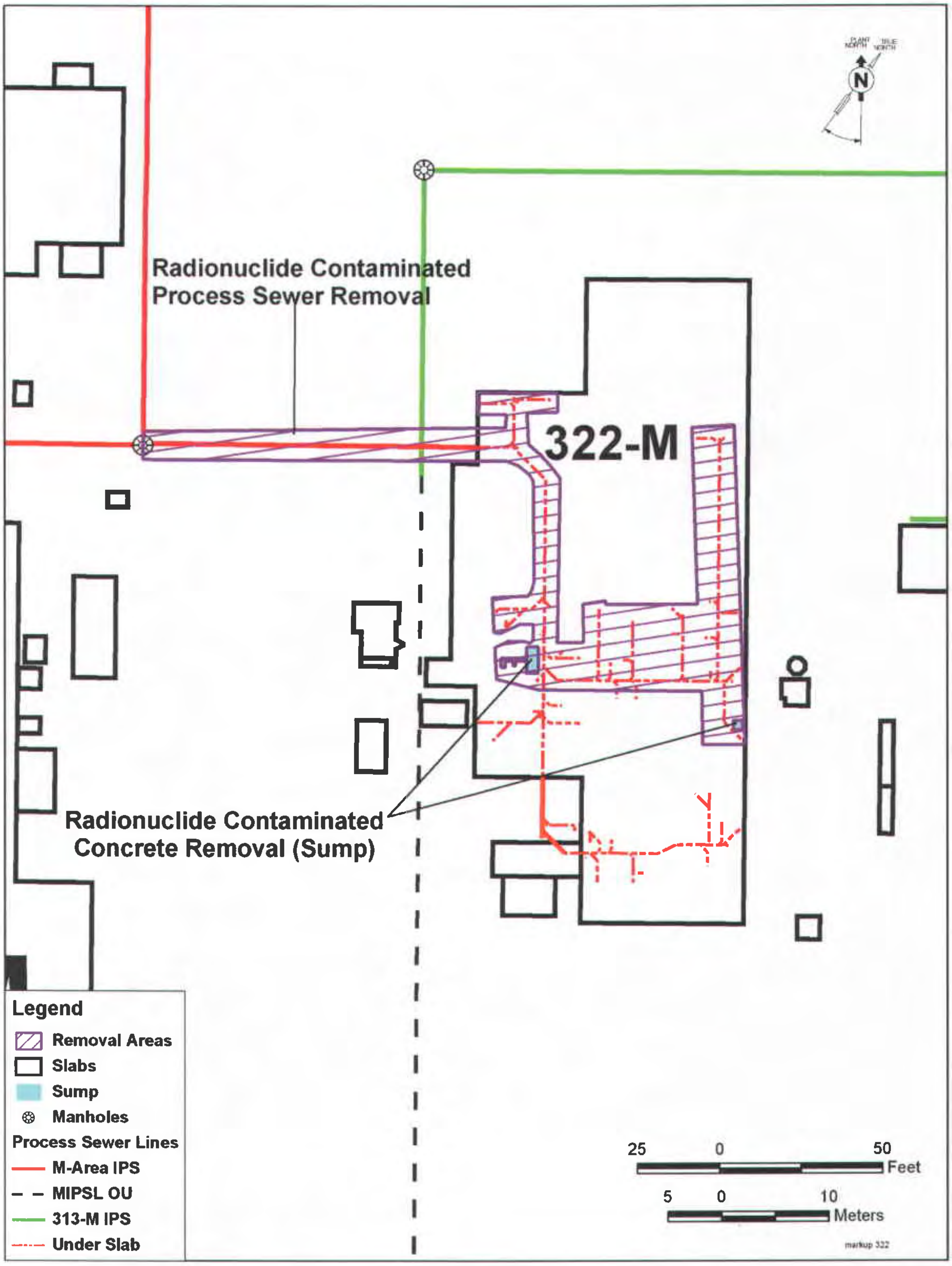


Figure 8-4. 322-M Problem Areas for Early Action, Status = Completed

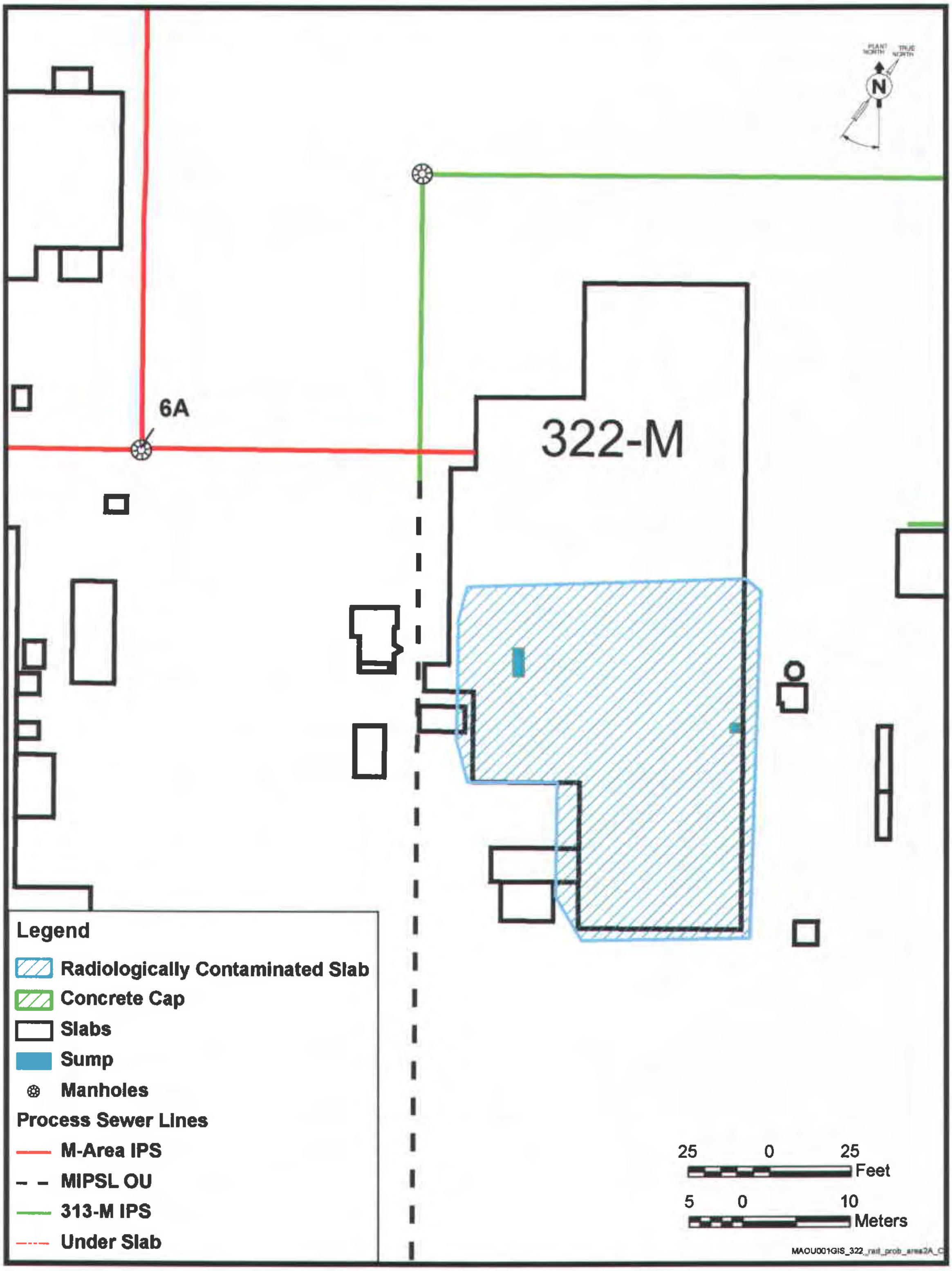


**Figure 8-5. 322-M Problem Areas for Early Action, Status = Planned**

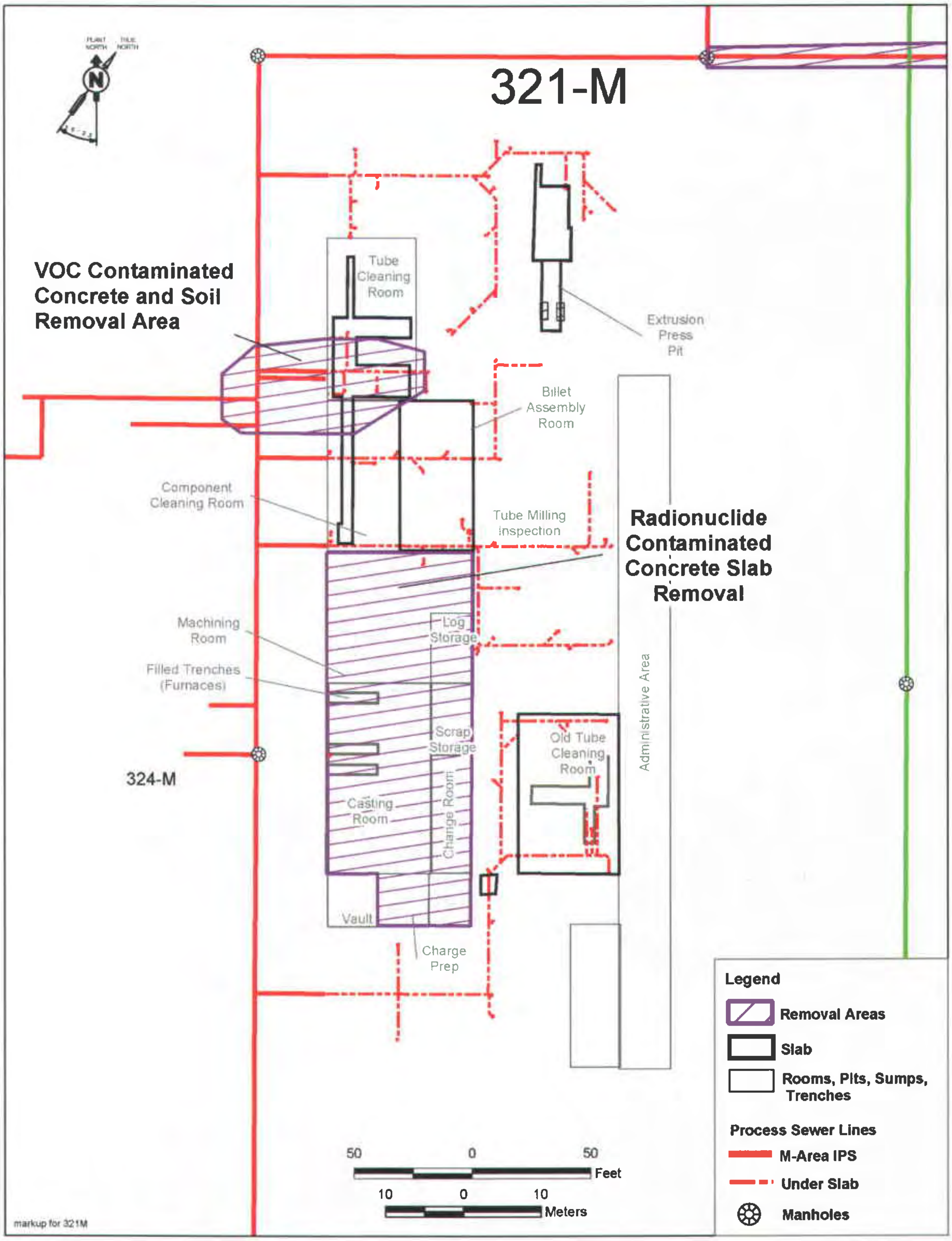


Figure 8-6. 321-M Problem Areas for Early Action - Slab Removal, Status = Planned

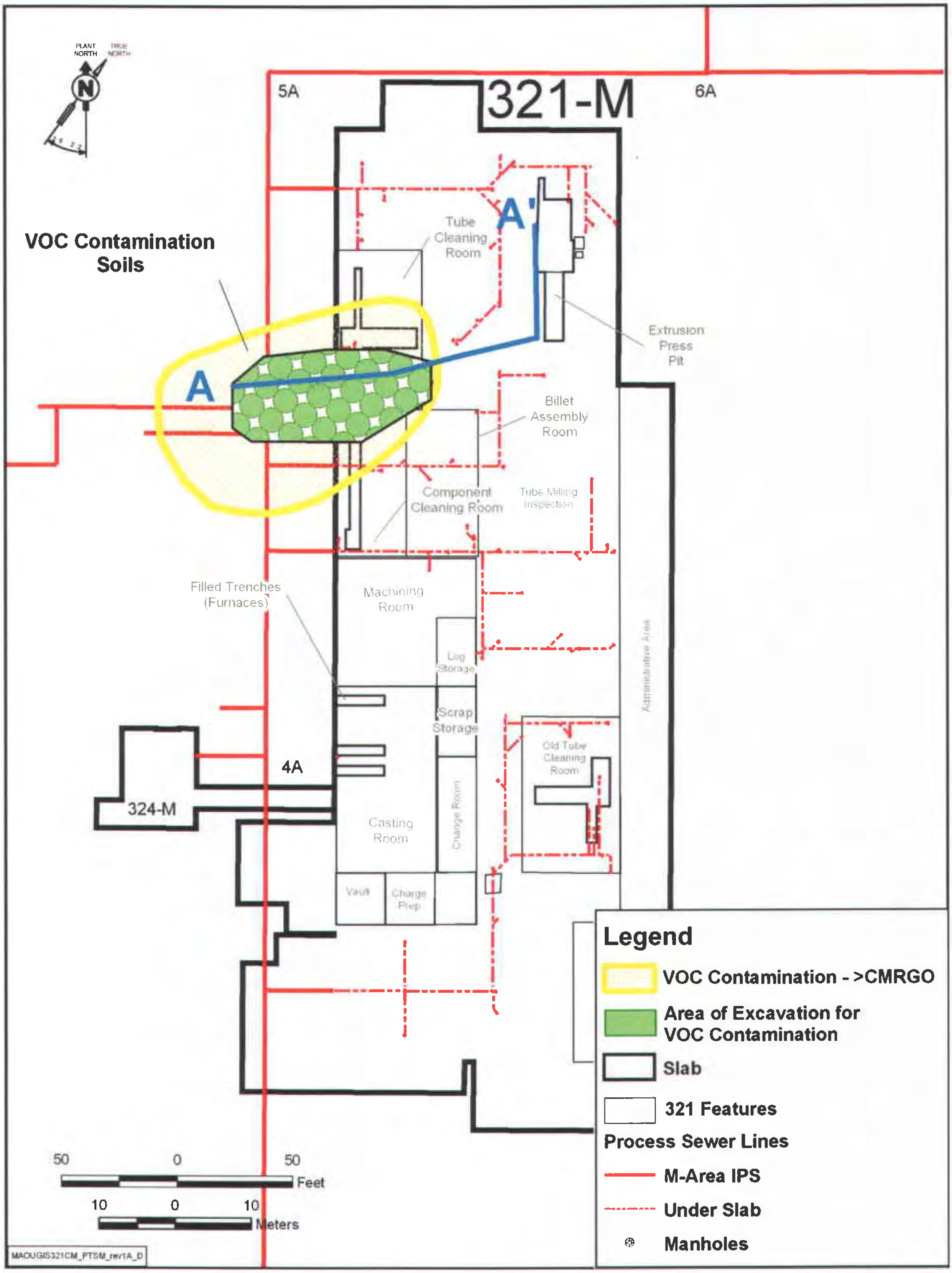


Figure 8-7. 321-M Problem Areas for Early Action - Soil Removal in Progress

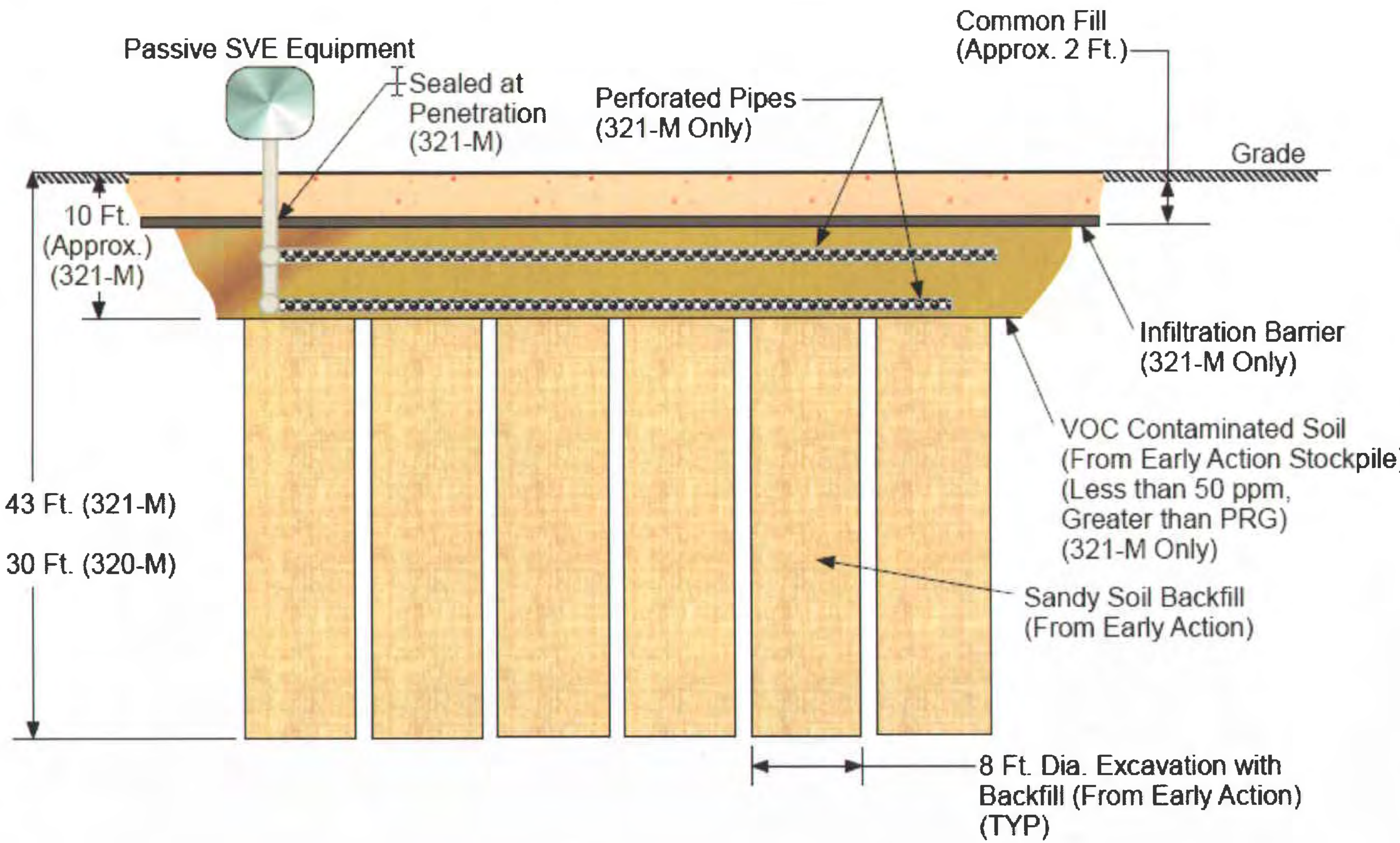


**Figure 8-8. PSVE Configuration for 321-M (Not to Scale)**

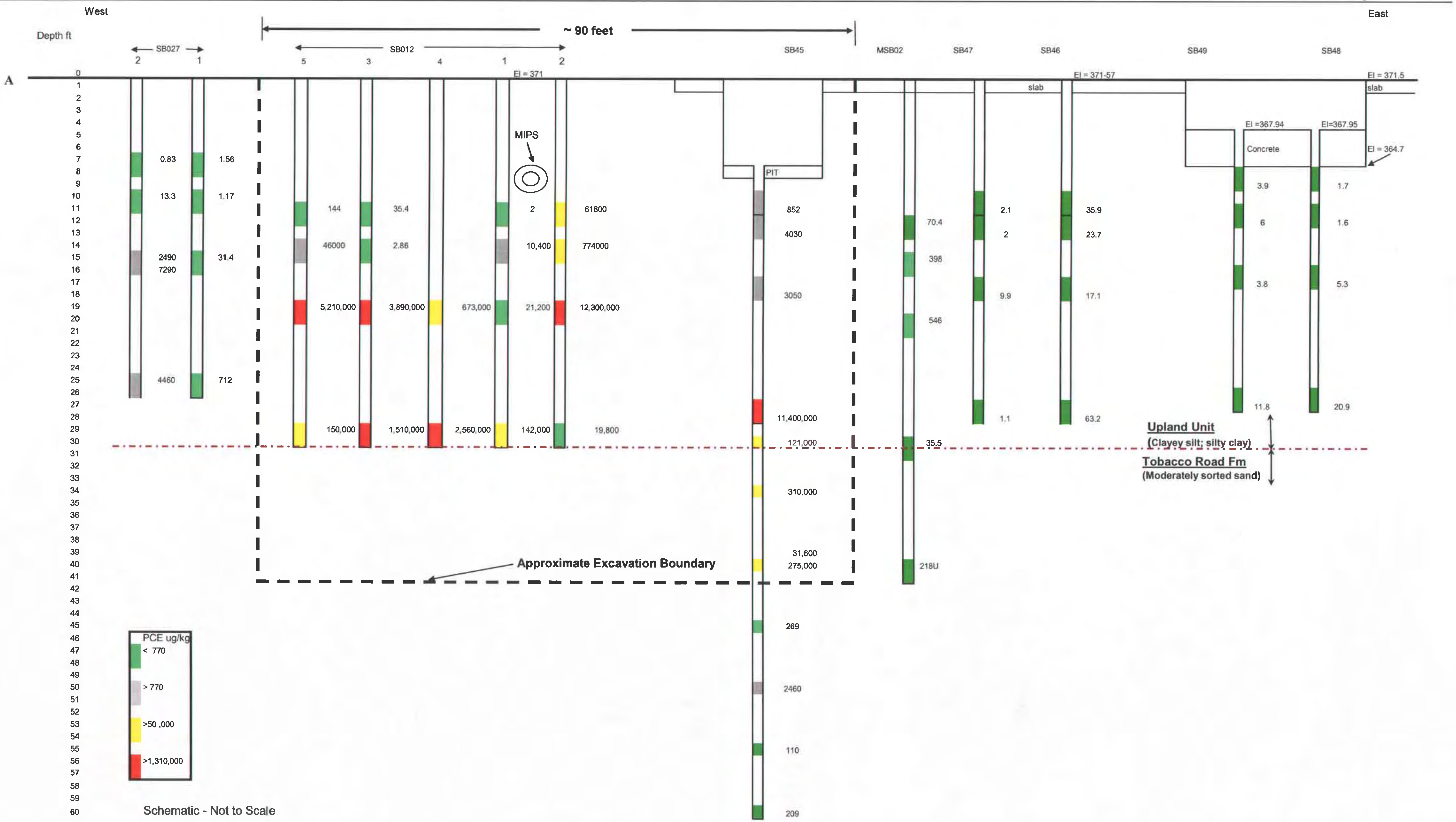


Figure 8-9. 321-M A-A' Cross Section of PCE Levels in Soil

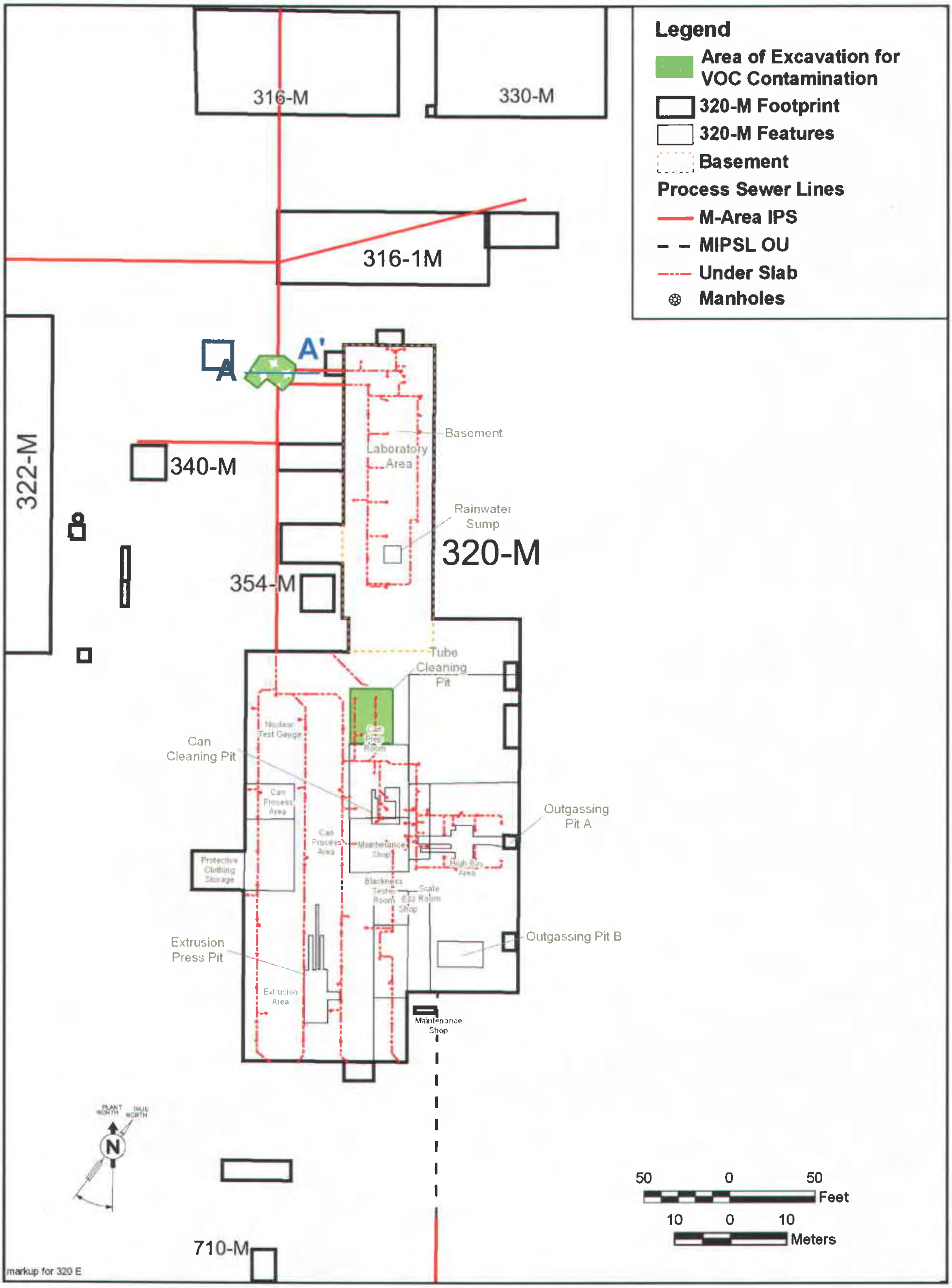


Figure 8-10. 320-M Problem Areas for Early Action - Soil Removal in Progress

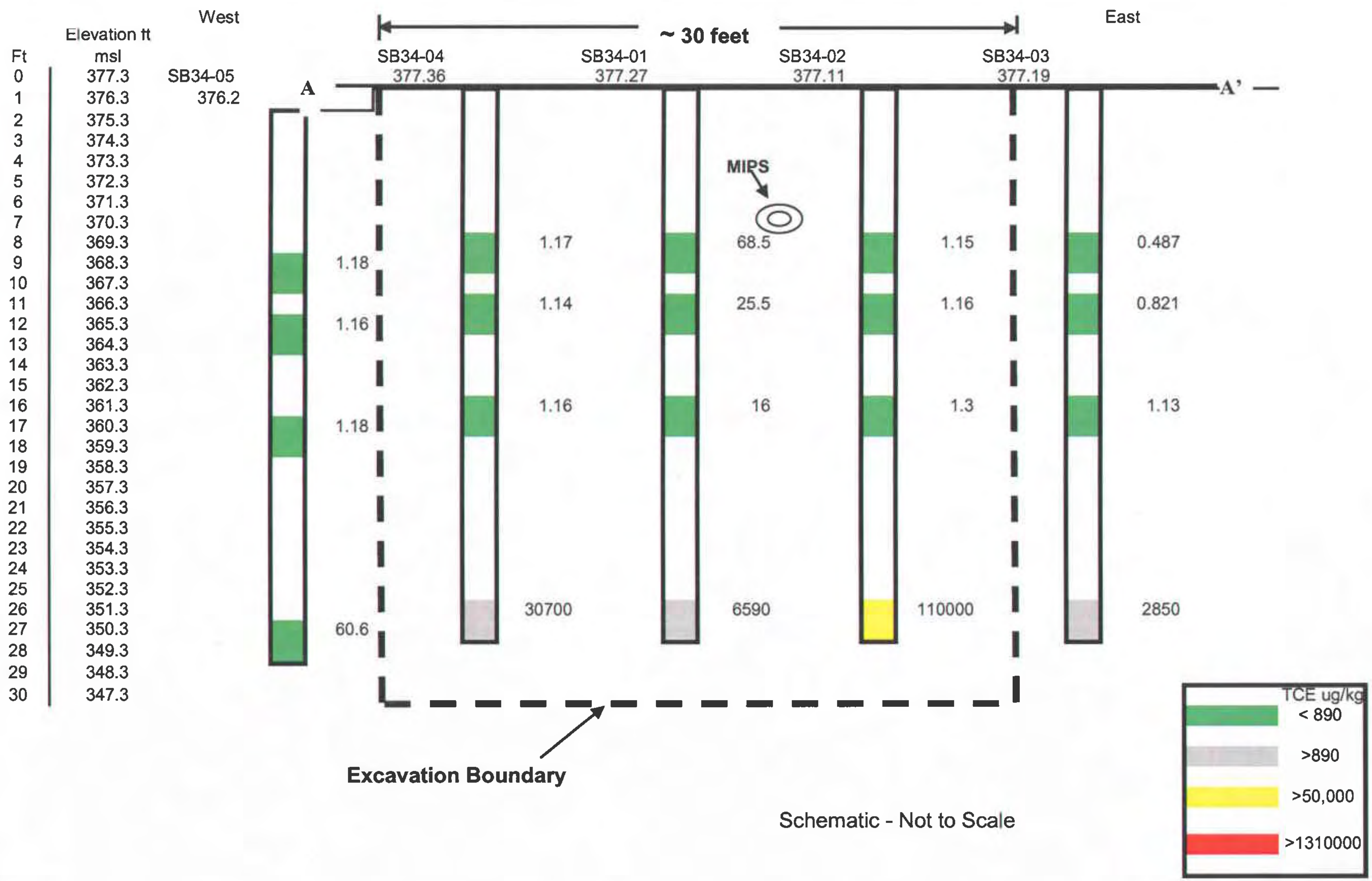


**Figure 8-11.** **320-M A-A' Cross Section of TCE Levels in Soil**

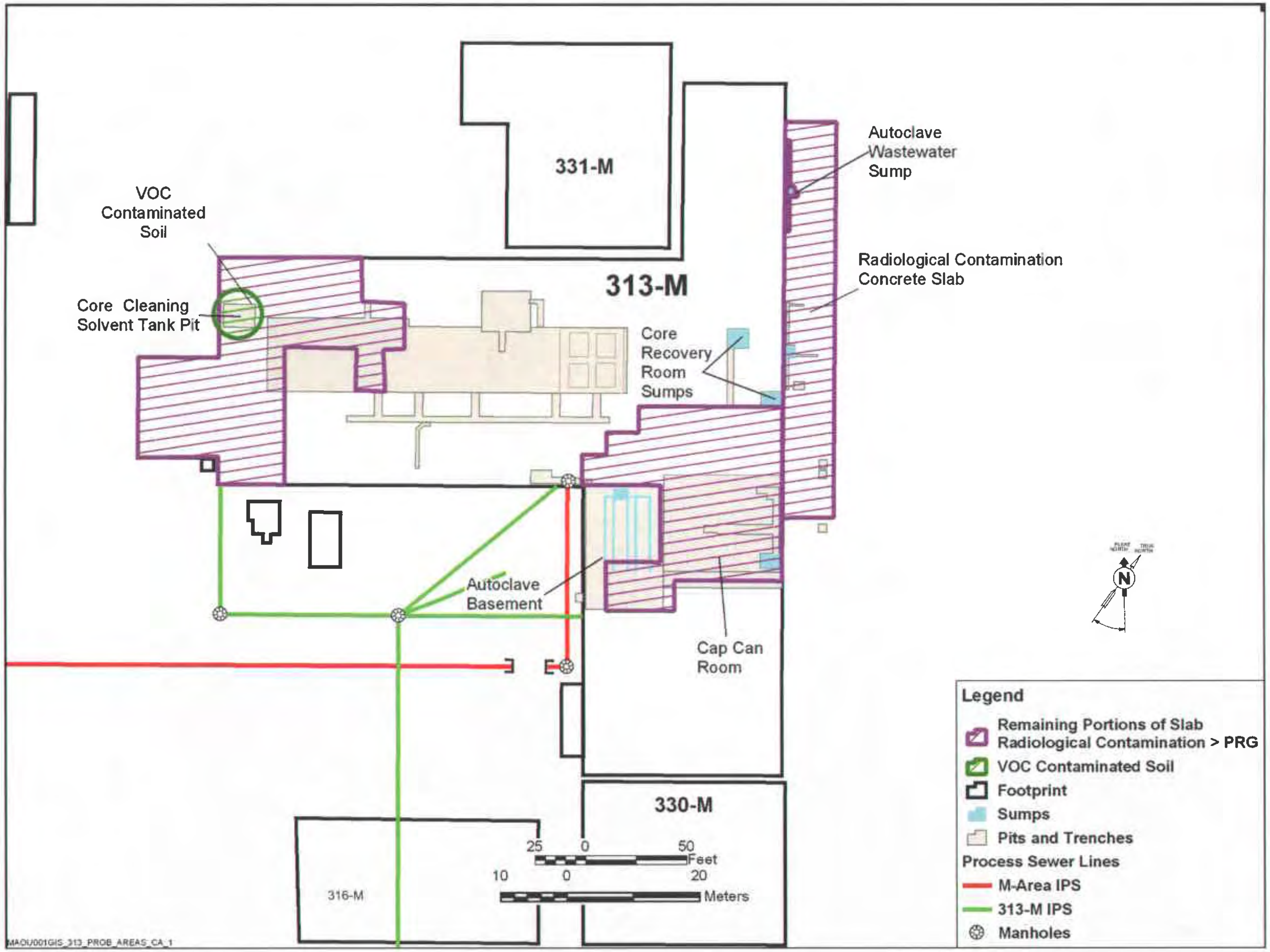


**Figure 8-12. 313-M Problem Areas for Early and Final Actions**

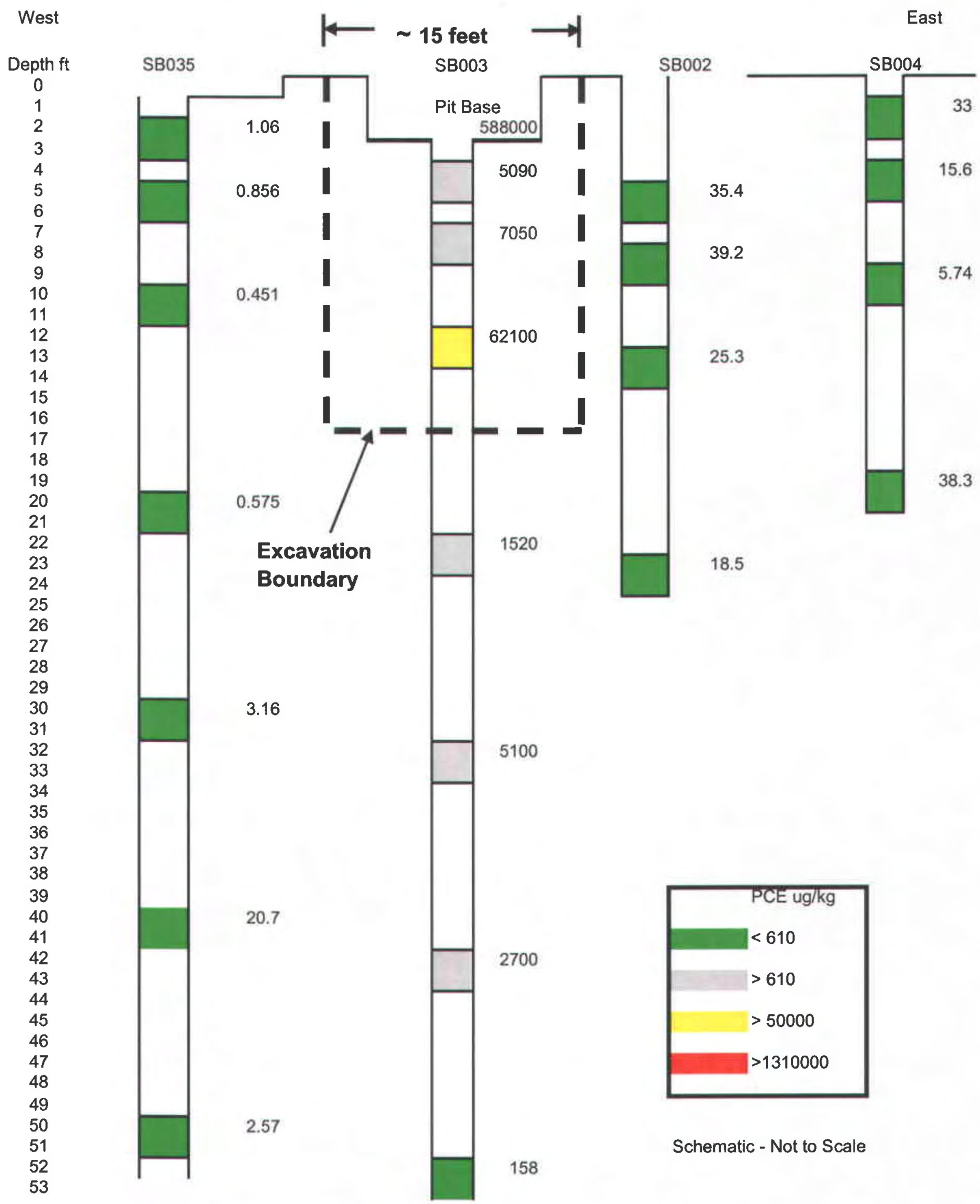


**Figure 8-13.** 313-M Cross Section of PCE Levels in Soil at Core Cleaning Solvent Tank Area

## 9. FINAL ACTION CONTAMINANT MIGRATION ANALYSIS AND ESTIMATE OF REMEDIATION TREATMENT TIME

The following MAOU facilities will be subject to final actions for PCE/TCE in soil: 321-M Tube Cleaning Room area, 320-M MIPSL Tie-in area, 313-M Core Cleaning Solvent Tank Pit area, and MIPSL Manhole 4A. Following is a discussion of the details and results of model simulations used to predict the efficacy of the planned final actions for these facilities, and the calculation for estimating PCE removal rates/treatment times.

Operation of PSVE at MAOU 321-M, 320-M and 313-M Facilities
The main soil vapor flow and contaminant transport processes utilized to recover PCE/TCE by PSVE include advection, mechanical dispersion, molecular diffusion, and mass transfer (partitioning between soil vapor/soil water phases and soil vapor/NAPL phases). Soil vapor transport occurs in response to soil vapor pressure and chemical concentration gradients, and advection occurs as a result of bulk soil vapor flow in response to a pressure gradient. The use of a SVE well imposes a pressure gradient across the soil vapor flow field, and for PSVE the pressure gradient is the difference between atmospheric (barometric) pressure and soil vapor pressure (at depth). To a lesser extent, PSVE pressure gradients result from soil vapor density differences between soil vapor with high concentrations of PCE/TCE and less contaminated soil vapor.

As mentioned above, advective flow is the transport process whereby gas moves as a continuum simply driven by a pressure gradient. PSVE takes advantage of a natural gradient between barometric pressure/subsurface soil vapor pressure for moving contaminants in soil vapor towards an extraction well. When soil vapor pressure exceeds barometric pressure (such as a low pressure stormy weather system), soil vapor flows from the subsurface and is vented out of the extraction well. When barometric pressure is greater than soil vapor pressure (i.e., a stable weather system), a device called a Baroball™ acts as a one-way flow valve and prevents atmospheric air from flowing in the opposite direction down the well. The ball in the Baroball™ seats and prevents backwards flow. Figure 9-1 shows the operation of a PSVE well and a diagram of a Baroball™ that only permits one-way flow of soil vapor out of the well.

As discussed in Section 8, an early action at 321-M includes using a large-diameter auger to drill soil columns to 42 ft and backfilling the columns with permeable sand. The final action involves returning stockpiled soil (>PRG and <50 mg/kg PCE) to the top, installing a horizontal PSVE system with vertical pipes fitted with Baroballs and covering the excavated are with a low-permeability geosynthetic cover. As shown in Figure 8-9, the contaminants exist in the Upland Unit (lower-permeability silty clay/clayey silt) and extend deeper into the higher-permeability Tobacco Road Formation (sorted sand). During periods of low atmospheric pressure, the pressure differential will be great across the 'tighter' Upland Unit and air will flow freely from the deeper (and laterally extensive) Tobacco Road Formation. This will result in rapid mass transfer of PCE out of the Upland Unit soil (remaining after the removal), and the <50 mg/kg PCE contaminated soil.

An early action at 320-M is similar in that the same excavation methods and soil columns are planned, but the excavation is to the base of the Upland Unit and covers a much smaller area. The PSVE system planned for 320-M includes several Baroball™ wells. The PSVE systems planned for the 313-M and MIPSL Manhole 4A areas consist of one or two Baroball™ wells installed in backfill at 313-M and in the native soil at MIPSL Manhole 4A. The PCE/TCE recovery from the PSVE systems in the Upland Unit will be controlled by advection and then become diffusion-dominant over time.

Unlike saturated flow systems, the affects of diffusion in air are greater than mechanical dispersion because gas-phase diffusion coefficients are much larger than aqueous-phase diffusion coefficients (around four orders of magnitude for PCE/TCE). However, it is expected that the contaminant removal rate will still be somewhat higher during earlier stages of PSVE operation than when diffusion is the dominant process. Fortunately, as discussed below it is estimated that very little PCE/TCE mass remains to be recovered as residuum in soil at 320-M, 313-M and MIPSL Manhole 4A.

Simulation of the Effects of the 321-M, 320-M, 313-M and MIPSL Manhole 4A Final Actions
Following is a summary of the set-up methods and computations for each of the SESOIL models used for simulating the effects of the final action remedies. The use of the SESOIL model is for simulating the final actions is conservative as it does not explicitly account for air flux through the vadose zone. The results are summarized below.

**321-M Tube Cleaning Room Area Final Action**
The contaminant load in the model includes PCE in the remaining 30% soil in the excavation, PCE mass in stockpiled soil <50 mg/kg, and the residual PCE contamination below the excavation. Also, the model simulates the effects of the final action (PSVE) and infiltration control (geosynthetic layer).

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) geosynthetic layer (1 ft), k = $1.0x10^{-13}$ $cm^2$, b) stockpiled soil (0-10 ft, PCE=50 mg/kg) and SCL layer 10-42 ft, where 30% of the soil and PCE remains, k=$8.5x10^{-10}$ $cm^2$, c) SCL layer from 42-141 ft, k = $8.5x10^{-11}$ $cm^2$, contains residual PCE mass, and d) CL/LS layer from 141-145 ft, k = $8.5x10^{-11}$ $cm^2$ (no PCE).

2) Excavation footprint = 2,260 $ft^2$, excavation depth = 42 ft, 70% of the soil is excavated, and the soil volume removed = 65,600 $ft^3$ (2,430 $yd^3$). Note that the soil treatment area may significantly expand when stockpiled soils are added.

3) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 75 (5.35 $cm^2$/sec) to account for 70% soil removal and installation of 'sand columns' in the voids and operation of the PSVE system in the stockpiled soil.

4) Distributed PCE into layers 2 and 3 (in layer 2 the PCE concentration = 50 mg/kg in sublayers 1 to 3 which is the maximum for PCE concentration in stockpiled soil and 3 mg/kg in sublayers 8-10 which is the final action RGO for the PCE in the soil that remains in the excavation area). PCE was distrinuted in layer 3 to simulate residual PCE below the excavation (= 2.4 mg/kg in sublayer 1 at 42-52 ft bgs, 0.15 mg/kg in sublayers 2 to 5 at 52-92 ft bgs, and 0.05 in sublayers 6 to 10 at 92-142 ft bgs). The PCE concentrations in layer 3 are representative of data from MIPS-SB045, a soil boring where the deepest DNAPL PCE concentrations were observed and the deepest boring beneath the contaminated soil at 321-M (see Figure 8-9). In layer 3 the PCE concentration used for sublayers 2 to 5 (0.15 mg/kg) is assumed and greater than the PCE concentration observed in the boring at that depth (0.11 mg/kg). The PCE concentration used for sublayers 6 to 10 is assumed (one-third of the PCE concentration used in sublayers 2 to 5). Next, performed computations to calculate the time that PCE contamination remaining in soil will reach groundwater with the low-permeability geosynthetic liner in-place. Predicted if soil PCE contamination will impact groundwater above the MCL.

The 321-M soil profile, modeling parameters used and contaminant loading for the final action is provided in Table 9-1. The SESOIL water balance (with geosynthetic cover in place) is satisfactory (shown in Table 9-5).

Computations:
(SEVIEW filename = 321FI5)
The SESOIL modeling results, including the predicted contaminant mass phase distribution and maximum leachate concentration is presented in Figure 9-2. As the figure shows, virtually all of the PCE mass in soil is removed via volatilization. Also, the calculated time for PCE soil contamination to reach the water table is 60 years and the maximum predicted PCE leachate concentration is negligible. The model predicts that the final action will be successful at preventing PCE impacts to groundwater at 321-M.

### 320-M MIPSL Tie-in Area Final Action

The contaminant load in the model includes the TCE mass in the remaining 30% soil in the excavation. Also, the model simulates the effects of the final action (compacted soil layer and PSVE wells).

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL layer 1-30 ft, where 30% of the soil and TCE remains, k=$8.5x10^{-10}$ $cm^2$, c) SCL layer from 30-141 ft, k = $6.5x10^{-11}$ $cm^2$, c) CL/LS layer from 141-145 ft, k = $8.5x10^{-11}$ $cm^2$, and d) bottom layer from 145-155 ft, $8.5x10^{-10}$ $cm^2$.
2) Excavation footprint = 215 $ft^2$, excavation depth = 30 ft, 70% excavated, soil volume removed = 4,594 $ft^3$ (170 $yd^3$).
3) Increased the air diffusion coefficient for TCE (0.072 $cm^2$/sec) by a factor of 75 (5.35) $cm^2$/sec) to account for 70% soil removal and installation of 'sand columns' in the voids and operation of the PSVE system.
4) Distributed TCE into layer 1 (15 mg/kg in sublayers 8-10 at 21-30 ft bgs to simulate the remaining TCE in the excavation area). It is assumed that TCE is negligible deeper than 30 ft bgs. Note that recent data (six grab samples collected at 30 ft bgs during soil excavation) shows that the average TCE concentration = 0.6 mg.kg and the maximum is 2.6 mg/kg at this depth, less than the soil RGO of 15 mg/kg. Next, performed computations to calculate the time that TCE contamination remaining in soil will reach groundwater. Predicted if soil TCE contamination will impact groundwater above the MCL.

The 320-M soil profile, modeling parameters used and contaminant loading for the final action is provided in Table 9-2. The SESOIL water balance is satisfactory (shown in Table 9-6).

Computations:

(SEVIEW filename = 320RE4)
The SESOIL modeling results, including the predicted contaminant mass phase distribution and maximum leachate concentration is presented in Figure 9-3. As the figure shows, most of the TCE mass in soil is removed via volatilization. The calculated time for TCE soil contamination to reach the water table is 6 years, the maximum predicted TCE leachate concentration is 0.015 mg/L and the predicted concentration in groundwater is less than the MCL. The model predicts that the final action will be successful at preventing TCE impacts to groundwater at 320-M.

### 313-M Core Cleaning Solvent Tank Pit Area Final Action

The contaminant load includes the residual PCE contamination below the excavation (>20 ft deep). The model is similar to the 313-M model discussed in Section 6, except that this model also simulates the effects of the final action (PSVE).

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) LS 0-20 ft, k=$8.5x10^{-10}$ $cm^2$, (layer where soil was removed and replaced with fill), b) SCL 20-141 ft, k = $6.5x10^{-11}$ $cm^2$, c) CL 141-145 ft, k = $8.5x10^{-12}$ $cm^2$, and d) LS 145-155 ft, k = $8.5x10^{-10}$ $cm^2$.
2) Excavation footprint = 150 $ft^2$
3) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 75 (5.35 $cm^2$/sec) to account for PSVE.
4) Distributed the PCE concentrations observed in soil boring 313M-003 (the soil boring beneath the pit where the highest PCE concentrations were observed as shown in Figure 8-13). The modeled PCE load included 3.3 mg/kg (20-32 ft bgs), 2.7 mg/kg (32-44 ft bgs), 0.057 mg/kg (44-56 ft bgs), 0.054 mg/kg (56-80.5 ft bgs), 0.009 (80.5-93 ft bgs), 0.006 (93-105 ft bgs), and 0.002 mg/kg (105-129 ft bgs). Note that PCE concentrations deeper than 53 ft bgs are estimated.

The 313-M soil profile, modeling parameters used and contaminant loading for the final action is provided in Table 9-3. The SESOIL water balance is satisfactory (Table 9-7).

Computations:

(SEVIEW filename = 313F1)
The SESOIL modeling results, including the predicted contaminant mass phase distribution and maximum leachate concentration is presented in Figure 9-4. As the figure shows, virtually all of the PCE mass in soil is removed via volatilization. Also, the calculated time for PCE soil contamination to reach the water table is six years and the maximum predicted PCE leachate concentration is 3.6 µg/L. The model predicts that the final action will be successful at preventing any significant PCE impacts to groundwater at 313-M.

**MIPSL Manhole 4A Final Action**

The contaminant load includes the residual PCE contamination represented by MIPS-SB-015 soil borings. The model is similar to the MIPSL Manhole 4A model discussed in Section 6, except that this model also simulates the effects of the final action (PSVE).

Model Set-up Methods:

1) Vertical discretization = 4 layers (each has 10 sublayers equally divided), a) SCL 0-20 ft, $k=6.5x10^{-11}$ $cm^2$, (source layer), b) SCL 20-141 ft, $k = 6.5x10^{-11}$ $cm^2$, c) CL 141-145 ft, $k = 8.5x10^{-12}$ $cm^2$, and d) LS 145-155 ft, $k = 8.5x10^{-10}$ $cm^2$.
2) Footprint = 15 ft x 15 ft = 225 $ft^2$
3) Since PCE>TCE, used PCE concentration data from MIPS-SB-015 soil borings, averaged for 0-2 ft (0.003 mg/kg), 3-5 ft (0.007 mg/kg), 8-10 ft (0.14 mg/kg), and 18-20 ft (2.0 mg/kg) intervals.
4) Increased the air diffusion coefficient for PCE (0.072 $cm^2$/sec) by a factor of 75 (5.35 $cm^2$/sec) to account for PSVE.

The MIPSL Manhole 4A soil profile, modeling parameters used and contaminant loading for the final action is provided in Table 9-4. The SESOIL water balance is satisfactory (shown in Figure Table 9-8).

Computations:

(SEVIEW filename = MP4A4)
The SESOIL modeling results, including the predicted contaminant mass phase distribution and maximum leachate concentration is presented in Figure 9-5. As the figure shows, virtually all of the PCE mass in soil is removed via volatilization. The calculated time for PCE soil contamination to reach the water table is 31 years and the maximum predicted PCE leachate concentration is negligible. The model predicts that the final action will be successful at preventing PCE impacts to groundwater at MIPSL Manhole 4A.

Summary of Final Action Modeling Results
The calculated time for soil contaminants to reach the water table ranges from 6 yrs at 313-M and 320-M to 60 yrs at 321-M, and the maximum predicted contaminant leachate concentration is 3.6 µg/L (less than the MCL) at 313-M. The predicted leachate concentration is negligible at the other facilities. Almost all of contaminant mass in soil is removed via volatilization at all of the facilities. As such, expansion of the soil treatment area at 321-M by adding stockpiled soil will not affect the predicted leachate concentration. The modeling predicts that the final actions planned for the MAOU facilities will be successful at preventing PCE/TCE impacts to groundwater.

Estimation of Remediation Treatment Time
The site-specific SRS data for a PSVE system operating in the Upland Unit in M-Area show PCE/TCE mass recovery rates as high as 8.3 kg/yr (WSRC 2004b). An estimate of the residual PCE/TCE mass and the treatment times required for the MAOU facilities (based on applying scaling factors for each PSVE system to the site-specific mass removal rate) is provided in Table 9-9. As the table shows, the residual mass at 321-M is significantly greater than the other facilities and estimated treatment times range from a very short duration at 320-M, 313-M and MIPSL Manhole 4A to >20 years for the 321-M PSVE treatment system.

However, it is possible that the estimated treatment time in Table 9-9 for 321-M is over-estimated. The effects of mechanical mixing and heat applied during the removal process and resultant vaporization is not considered in the calculation. In addition, the pressure differential between the Tobacco Road Formation and the atmosphere during low barometric pressure periods was not considered (i.e., the result of the lower permeability SCL that acts as an infiltration/barometric pressure barrier). These conditions will likely result in lower initial contaminant mass, more rapid advective process treatment and also improve diffusion rates for PCE out of less permeable materials. These conditions further reinforce the acceptability of a PSVE strategy.

**Table 9-1. 321-M SESOIL Profile, Modeling Parameters and PCE Loading for Final Action**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 30.5 | 1.00 | 1.00E-13 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 1290.0 | 42.32 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 3050.0 | 100.07 | 8.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 457.0 | 14.99 | 8.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | ($g/cm^3$) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 7.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 2.10E+6 |
| | $ft^2$ | 2260.42 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility | (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law | ($M^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ | (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance | (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient | ($cm^2$/sec) | 5.35 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient | ($cm^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight | (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\321FI5.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_321_.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\321_FINA.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 5.00E+01 | 5.00E+01 | 5.00E+01 | | | | | 3.00E+00 | 3.00E+00 | 3.00E+00 |
| Layer 3 (ug/g) | 2.40E+00 | 1.50E-01 | 1.50E-01 | 1.50E-01 | 1.50E-01 | 5.00E-02 | 5.00E-02 | 5.00E-02 | 5.00E-02 | 5.00E-02 |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 9-2. 320-M SESOIL Profile, Modeling Parameters and TCE Loading for Final Action**

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 914.0 | 29.99 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3380.0 | 110.89 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | | |
|---|---|---|
| Bulk Density | ($g/cm^3$) | 1.50 |
| Effective Porosity | (fraction) | 0.32 |
| Soil Pore Disconnectedness | | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 2.00E+5 |
| | $ft^2$ | 215.28 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | | |
|---|---|---|---|---|
| Water Solubility | (µg/mL) | 1.10E+3 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law | ($M^3$atm/mol) | 1.17E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ | (µg/g)/(µg/mL) | 166.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance | (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient | ($cm^2$/sec) | 5.35 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient | ($cm^2$/sec) | 9.10E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight | (g/mol) | 131.00 | | |

**Output File:**
C:\SEVIEW62\320RE4.OUT
**Chemical File:** Trichloroethylene (TCE)
C:\SEVIEW62\TCE.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | 1.50E+01 | 1.50E+01 | 1.50E+01 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

## Table 9-3. 313-M SESOIL Profile, Modeling Parameters and PCE Loading for Final Action

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density ($g/cm^3$) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 1.40E+5 |
| | $ft^2$ | 150.69 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law ($M^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient ($cm^2$/sec) | 5.35 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient ($cm^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\313F1.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\313_FIN.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | | | | | | | | | | |
| Layer 2 (ug/g) | 3.30E+00 | 2.70E+00 | 5.70E-02 | 5.40E-02 | 5.40E-02 | 9.00E-03 | 6.00E-03 | 2.00E-03 | 2.00E-03 | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

## Table 9-4. MIPSL Manhole 4A SESOIL Profile, Modeling Parameters and PCE Loading for Final Action

| Layer No. | Number of Sub-Layers | Thickness | | Intrinsic Permeability | Organic Carbon Content | Adsorption Coefficient | Cation Exchange Capacity | Freundlich Exponent | Solid Phase Degradation Rate | Liquid Phase Degradation Rate | Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cm | feet | $cm^2$ | percent | µg/g / µg/mL | mEq / 100 g soil | unitless | 1/day | 1/day | pH |
| 1 | 10 | 610.0 | 20.01 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 2 | 10 | 3690.0 | 121.06 | 6.50E-11 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 3 | 10 | 122.0 | 4.00 | 8.50E-12 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |
| 4 | 10 | 305.0 | 10.01 | 8.50E-10 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00E+00 | 0.00E+00 | 7.00 |

**Soil Parameters**

| | |
|---|---|
| Bulk Density ($g/cm^3$) | 1.50 |
| Effective Porosity (fraction) | 0.32 |
| Soil Pore Disconnectedness | 3.50 |

**Application Parameters**

| | | |
|---|---|---|
| Area | $cm^2$ | 2.09E+5 |
| | $ft^2$ | 224.97 |
| Latitude | degrees | 33.3 |
| Spill Index | | 1 |

**Chemical Parameters**

| | | | |
|---|---|---|---|
| Water Solubility (µg/mL) | 200.0 | Moles Ligand / Moles Chemical | 0.00 |
| Henry's Law ($M^3$atm/mol) | 2.68E-2 | Ligand Molecular Weight(g/mol) | 0.00 |
| $K_{oc}$ (µg/g)/(µg/mL) | 155.00 | Base Hydrolysis Rate(L/mol/day) | 0.00 |
| Valance (g/mole) | 0.00 | Ligand Dissociation Constant | 0.00 |
| Air Diffusion Coefficient ($cm^2$/sec) | 5.35 | Neutral Hydrolysis Rate (L/mol/day) | 0.00 |
| Water Diffusion Coefficient ($cm^2$/sec) | 8.20E-6 | Acid Hydrolysis Rate (L/mol/day) | 0.00 |
| Molecular Weight (g/mol) | 166.00 | | |

**Output File:**
C:\SEVIEW62\MP4A4.OUT
**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM
**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI
**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\4A_AP.APL

| Sublayer Loads | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer 1 (ug/g) | 3.00E-03 | 7.00E-03 | 5.20E-03 | | 1.40E-01 | | | | | 2.00E+00 |
| Layer 2 (ug/g) | | | | | | | | | | |
| Layer 3 (ug/g) | | | | | | | | | | |
| Layer 4 (ug/g) | | | | | | | | | | |

**Table 9-5. 321-M SESOIL Water Balance (Final Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 4.46 | 1.76 | 2.77 | 1.09 | 3.34 | 1.31 | -0.63 | -0.25 | 0.06 | 0.02 | 18.45 | 18.45 |
| November | 4.52 | 1.78 | 2.74 | 1.08 | 2.43 | 0.96 | 0.25 | 0.10 | 0.05 | 0.02 | 18.51 | 18.51 |
| December | 5.09 | 2.00 | 4.51 | 1.78 | 1.82 | 0.72 | 2.66 | 1.05 | 0.06 | 0.02 | 18.86 | 19.17 |
| January | 7.09 | 2.79 | 4.61 | 1.81 | 2.13 | 0.84 | 2.41 | 0.95 | 0.07 | 0.03 | 19.77 | 19.77 |
| February | 7.11 | 2.80 | 4.36 | 1.72 | 3.65 | 1.44 | 0.63 | 0.25 | 0.08 | 0.03 | 19.93 | 19.93 |
| March | 8.27 | 3.26 | 5.26 | 2.07 | 5.17 | 2.04 | 0.00 | 0.00 | 0.09 | 0.04 | 19.93 | 19.93 |
| April | 5.73 | 2.26 | 3.88 | 1.53 | 5.47 | 2.15 | -1.65 | -0.65 | 0.09 | 0.04 | 19.21 | 19.52 |
| May | 5.90 | 2.32 | 4.60 | 1.81 | 5.78 | 2.28 | -1.27 | -0.50 | 0.09 | 0.04 | 19.21 | 19.21 |
| June | 8.04 | 3.17 | 4.86 | 1.91 | 6.08 | 2.39 | -1.27 | -0.50 | 0.08 | 0.03 | 18.58 | 18.89 |
| July | 7.58 | 2.98 | 5.45 | 2.15 | 6.38 | 2.51 | -1.01 | -0.40 | 0.08 | 0.03 | 18.64 | 18.64 |
| August | 8.05 | 3.17 | 5.31 | 2.09 | 5.78 | 2.28 | -0.51 | -0.20 | 0.07 | 0.03 | 18.20 | 18.51 |
| September | 4.89 | 1.93 | 3.99 | 1.57 | 4.56 | 1.80 | -0.63 | -0.25 | 0.06 | 0.02 | 18.36 | 18.36 |
| Total | 76.73 | 30.21 | 52.32 | 20.60 | 52.59 | 20.71 | -1.01 | -0.40 | 0.88 | 0.35 | | |

**Table 9-6. 320-M MIPSL Tie-in Area SESOIL Water Balance (Final Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 2.93 | 1.15 | 4.25 | 1.67 | 3.34 | 1.31 | -1.01 | -0.40 | 1.92 | 0.76 | 17.21 | 17.21 |
| November | 3.02 | 1.19 | 4.26 | 1.68 | 2.43 | 0.96 | 0.13 | 0.05 | 1.70 | 0.67 | 17.25 | 17.25 |
| December | 3.06 | 1.20 | 6.47 | 2.55 | 1.82 | 0.72 | 2.90 | 1.14 | 1.75 | 0.69 | 17.98 | 17.98 |
| January | 4.68 | 1.84 | 7.08 | 2.79 | 2.13 | 0.84 | 3.02 | 1.19 | 1.93 | 0.76 | 18.75 | 18.75 |
| February | 4.73 | 1.86 | 6.66 | 2.62 | 3.65 | 1.44 | 0.88 | 0.35 | 2.13 | 0.84 | 18.97 | 18.97 |
| March | 5.48 | 2.16 | 7.99 | 3.15 | 5.17 | 2.04 | 0.38 | 0.15 | 2.45 | 0.96 | 19.07 | 19.07 |
| April | 3.87 | 1.52 | 5.93 | 2.33 | 5.47 | 2.15 | -2.01 | -0.79 | 2.47 | 0.97 | 18.56 | 18.56 |
| May | 3.69 | 1.45 | 6.81 | 2.68 | 5.78 | 2.28 | -1.51 | -0.59 | 2.55 | 1.00 | 18.17 | 18.17 |
| June | 5.50 | 2.17 | 7.43 | 2.93 | 6.08 | 2.39 | -1.26 | -0.50 | 2.61 | 1.03 | 17.85 | 17.85 |
| July | 4.94 | 1.94 | 8.23 | 3.24 | 6.38 | 2.51 | -0.76 | -0.30 | 2.60 | 1.02 | 17.66 | 17.66 |
| August | 5.50 | 2.17 | 8.06 | 3.17 | 5.78 | 2.28 | -0.25 | -0.10 | 2.54 | 1.00 | 17.60 | 17.60 |
| September | 3.06 | 1.20 | 5.95 | 2.34 | 4.56 | 1.80 | -0.88 | -0.35 | 2.27 | 0.89 | 17.37 | 17.37 |
| Total | 50.46 | 19.87 | 79.13 | 31.15 | 52.59 | 20.71 | -0.38 | -0.15 | 26.92 | 10.60 | | |

**Table 9-7. 313-M SESOIL Water Balance (Final Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.01 | 1.19 | 4.17 | 1.64 | 3.34 | 1.31 | -0.99 | -0.39 | 1.82 | 0.72 | 17.00 | 17.00 |
| November | 3.10 | 1.22 | 4.18 | 1.65 | 2.43 | 0.96 | 0.12 | 0.05 | 1.62 | 0.64 | 17.03 | 17.03 |
| December | 3.24 | 1.28 | 6.48 | 2.55 | 1.82 | 0.72 | 2.98 | 1.17 | 1.67 | 0.66 | 17.79 | 17.79 |
| January | 4.84 | 1.91 | 6.95 | 2.74 | 2.13 | 0.84 | 2.98 | 1.17 | 1.85 | 0.73 | 18.55 | 18.55 |
| February | 4.90 | 1.93 | 6.56 | 2.58 | 3.65 | 1.44 | 0.87 | 0.34 | 2.04 | 0.80 | 18.77 | 18.77 |
| March | 5.57 | 2.19 | 7.74 | 3.05 | 5.17 | 2.04 | 0.25 | 0.10 | 2.33 | 0.92 | 18.83 | 18.83 |
| April | 4.00 | 1.57 | 5.84 | 2.30 | 5.47 | 2.15 | -1.99 | -0.78 | 2.35 | 0.93 | 18.33 | 18.33 |
| May | 3.82 | 1.50 | 6.71 | 2.64 | 5.78 | 2.28 | -1.49 | -0.59 | 2.42 | 0.95 | 17.95 | 17.95 |
| June | 5.68 | 2.24 | 7.32 | 2.88 | 6.08 | 2.39 | -1.24 | -0.49 | 2.48 | 0.98 | 17.63 | 17.63 |
| July | 5.11 | 2.01 | 8.11 | 3.19 | 6.38 | 2.51 | -0.74 | -0.29 | 2.47 | 0.97 | 17.44 | 17.44 |
| August | 5.68 | 2.24 | 7.94 | 3.13 | 5.78 | 2.28 | -0.25 | -0.10 | 2.41 | 0.95 | 17.38 | 17.38 |
| September | 3.17 | 1.25 | 5.85 | 2.30 | 4.56 | 1.80 | -0.87 | -0.34 | 2.16 | 0.85 | 17.16 | 17.16 |
| Total | 52.11 | 20.52 | 77.85 | 30.65 | 52.59 | 20.71 | -0.37 | -0.15 | 25.63 | 10.09 | | |

**Table 9-8. MIPSL Manhole 4A SESOIL Water Balance (Final Action)**

| | Surface Water Runoff | | Net Infiltration | | Evapotranspiration | | Soil Moisture Retention | | Groundwater Runoff (Recharge) | | Soil Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Layer 1 | Below Layer 1 |
| Units | cm | Inches | cm | Inches | cm | Inches | cm | Inches | cm | Inches | Percent | Percent |
| October | 3.21 | 1.26 | 4.17 | 1.64 | 3.34 | 1.31 | -0.87 | -0.34 | 1.70 | 0.67 | 17.21 | 17.21 |
| November | 3.21 | 1.26 | 4.07 | 1.60 | 2.43 | 0.96 | 0.12 | 0.05 | 1.51 | 0.59 | 17.24 | 17.24 |
| December | 3.33 | 1.31 | 6.22 | 2.45 | 1.82 | 0.72 | 2.85 | 1.12 | 1.55 | 0.61 | 17.97 | 17.97 |
| January | 5.06 | 1.99 | 6.81 | 2.68 | 2.13 | 0.84 | 2.98 | 1.17 | 1.70 | 0.67 | 18.72 | 18.72 |
| February | 4.98 | 1.96 | 6.26 | 2.46 | 3.65 | 1.44 | 0.74 | 0.29 | 1.87 | 0.74 | 18.91 | 18.91 |
| March | 5.78 | 2.28 | 7.55 | 2.97 | 5.17 | 2.04 | 0.25 | 0.10 | 2.13 | 0.84 | 18.97 | 18.97 |
| April | 4.11 | 1.62 | 5.65 | 2.22 | 5.47 | 2.15 | -1.99 | -0.78 | 2.16 | 0.85 | 18.47 | 18.47 |
| May | 4.04 | 1.59 | 6.65 | 2.62 | 5.78 | 2.28 | -1.37 | -0.54 | 2.24 | 0.88 | 18.12 | 18.12 |
| June | 5.88 | 2.31 | 7.13 | 2.81 | 6.08 | 2.39 | -1.24 | -0.49 | 2.29 | 0.90 | 17.81 | 17.81 |
| July | 5.21 | 2.05 | 7.79 | 3.07 | 6.38 | 2.51 | -0.87 | -0.34 | 2.27 | 0.89 | 17.59 | 17.59 |
| August | 5.87 | 2.31 | 7.75 | 3.05 | 5.78 | 2.28 | -0.25 | -0.10 | 2.22 | 0.87 | 17.52 | 17.52 |
| September | 3.27 | 1.29 | 5.68 | 2.24 | 4.56 | 1.80 | -0.87 | -0.34 | 1.99 | 0.78 | 17.30 | 17.30 |
| Total | 53.97 | 21.25 | 75.71 | 29.81 | 52.59 | 20.71 | -0.50 | -0.20 | 23.62 | 9.30 | | |

**Table 9-9. Estimated Effectiveness of PSVE and Time for Completion**

| Facility | | (A) Estimated PCE/TCE Mass Remaining After Early Action (if Early Action is Applicable) (kg)[1] | (B) Mass Removal Rate from SRS Upland Unit in WSRC 2004b (kg/yr)[2] | Scaling Factors[3] Formulas Used: H = (E/D) x B x C x F x G and I = A/H | | | | | | (I) Estimated Time for PCE/TCE Removal (yrs) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (C) Estimated No. of 8-ft Dia. Auger Borings or Equivalent to be Used at MAOU Facility | (D) MAPSL Boring Circum-ference in WSRC 2004b (ft) | (E) MAOU PSVE Boring Circum-ference That will be Used (ft) | (F) Scaled Boring Effective-ness Factor (unitless) | (G) MAOU Effective Porosity for Sand Fill in Columns, Stockpiled Soil, or Soil Treated in-place (unitless) | (H) 'Scaled' Upland Unit Removal Rate for MAOU Facility (kg/yr) | |
| 321-M Tube Cleaning Room | 30% Soil Remaining in Excavated Area | 20,000 | 8.3 | 30 | 0.52 | 25.1 | 0.7 | 0.25 | 2,105 | 9.5 |
| | Stockpiled Soil < 50 mg/kg | 4,200 | 8.3 | 25 | 0.52 | 1.6 | 0.8 | 0.40 | 200 | 21 |
| 320-M MIPSL Tie-in Area | | 7 | 8.3 | 4 | 0.52 | 25.1 | 0.7 | 0.25 | 279 | 0.03 |
| 313-M Solvent Storage Tank Pit | | 1 | 8.3 | NA | NA | NA | 0.5 | NA | NA | 0.06[4] |
| MIPSL Manhole 4A | | 1 | 8.3 | NA | NA | NA | 0.5 | NA | NA | 0.06[4] |

1 The contaminant mass remaining is calculated from the average soil concentration in the excavated area (units = contaminant mass/soil mass) x soil density (soil mass/soil volume) x the calculated soil volume. The calculated mass shown for the stockpiled soil (Column A) already accounts for 60% volatilization loss during soil excavation and handling. Note that the volume of stockpiled soil at 321-M may significantly increase. This will be accounted for during remedial design.

2 The removal rate is calculated from the average PCE/TCE mass flux reported in *Performance Testing of Passive Soil Vapor Extraction (PSVE) along the M-Area Abandoned Process Sewer Line (MAPSL)*, WSRC-TR-2004-00143, July 2005, pg. 41.

3 The scaling factors are used to correlate the MAPSL vertical PSVE system to the vertical and horizontal PSVE systems that will be installed at the MAOU facilities as final actions. The scaling factors include: the ratio of well boring circumferences (E/D), a multiplier for the number of 8-ft PSVE wells (or equivalent for the horizontal system) (C), the expected effectiveness of the MAO system as compared to the MAPSL system (F), and the effective porosity (G) of the sand columns (321-M and 320-M), stockpiled soil (321-M) and soil treated in-place by PSVE wells (313-M and MIPSL Manhole 4A).

4 Since the MAPSL PSVE system is very similar to the systems planned for 313-M and MIPSL Manhole 4A, the only scaling factor (multiplier) used is the 'Scaled Boring Effectiveness Factor'.

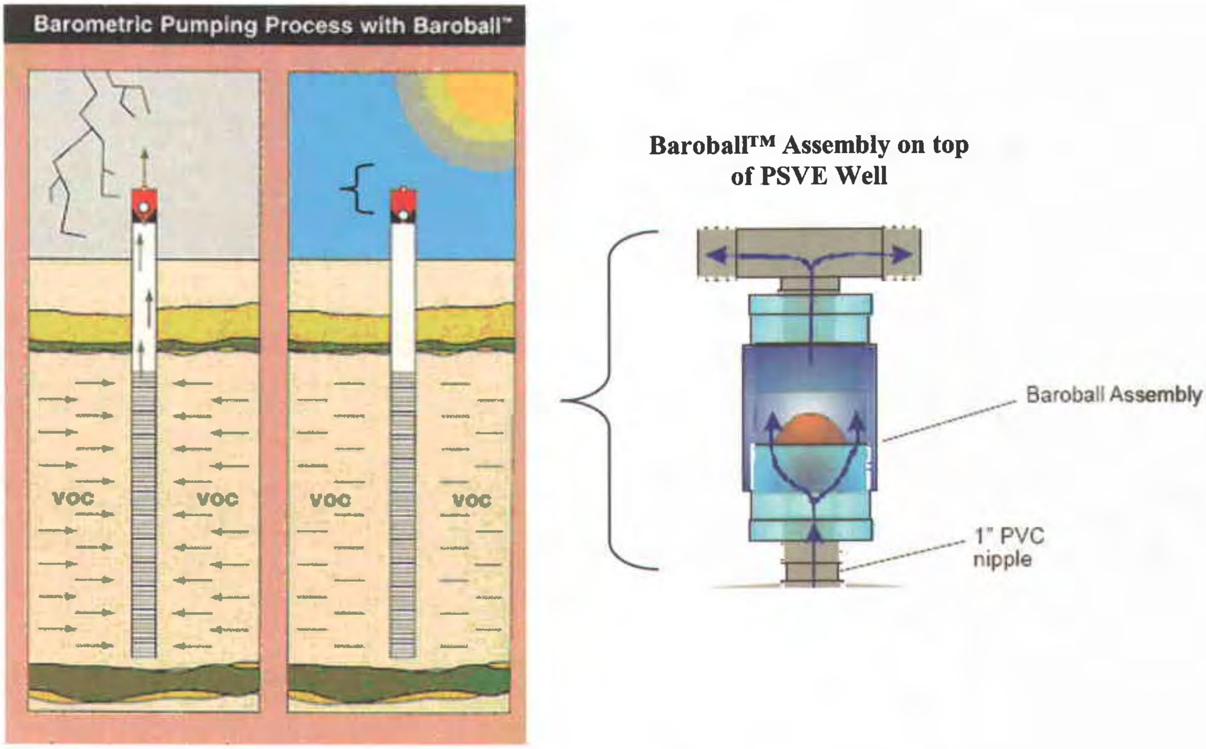


**Figure 9-1. Configuration of PSVE Well Equipped with a Baroball™**

**SESOIL Output File:** C:\SEVIEW62\321FI5.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 6.772E+10 | 100.00 |
| In Soil Air | 2.641E+00 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 6.426E-01 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 3.382E+00 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 3.498E-02 | 0.00 |
| Total Output | 6.772E+10 | 100.00 |
| Total Input | 6.773E+10 | |
| Input - Output | 2.950E+06 | |

**Maximum leachate concentration:** 1.007E-10 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_321_.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\321_FINA.APL

**Starting Depth:** 4217.00 **cm**
**Ending Depth:** 4825.00 **cm**
**Total Depth:** 4827.50 **cm**

**Figure 9-2. 321-M SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the Final Action**

**SESOIL Output File:** C:\SEVIEW62\320RE4.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 1.233E+08 | 99.95 |
| In Soil Air | 1.120E+01 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 8.011E+00 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 2.786E+01 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 4.203E+05 | 0.03 |
| Total Output | 1.233E+08 | 99.99 |
| Total Input | 1.234E+08 | |
| Input - Output | 1.688E+05 | |

**Maximum leachate concentration:** 1.536E-02 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Trichloroethylene (TCE)
C:\SEVIEW62\TCE.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\SILTY_CL.APL

**Starting Depth:** 957.20 cm
**Ending Depth:** 4721.00 cm
**Total Depth:** 4721.00 cm

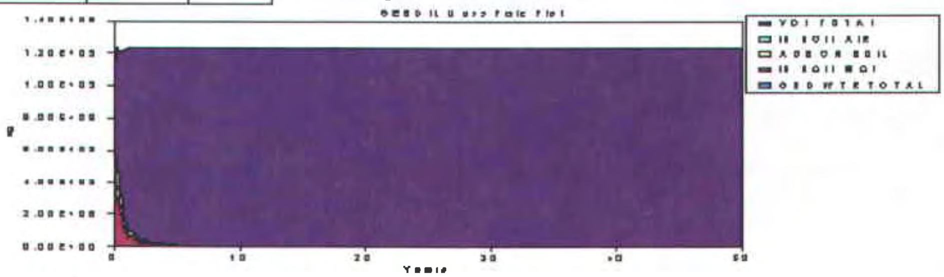

**Figure 9-3. 320-M SESOIL Modeling Results, Predicted TCE Mass and Phase Distribution for the Final Action**

**SESOIL Output File:** C:\SEVIEW62\313F1.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 4.791E+08 | 99.99 |
| In Soil Air | 2.053E-01 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 4.579E-02 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 2.253E-01 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 2.797E+04 | 0.01 |
| Total Output | 4.791E+08 | 99.99 |
| Total Input | 4.792E+08 | |
| Input - Output | 3.996E+04 | |

**Maximum leachate concentration:** 3.608E-03 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\313_FIN.APL

**Starting Depth:** 3819.00 cm
**Ending Depth:** 4727.00 cm
**Total Depth:** 4727.00 cm

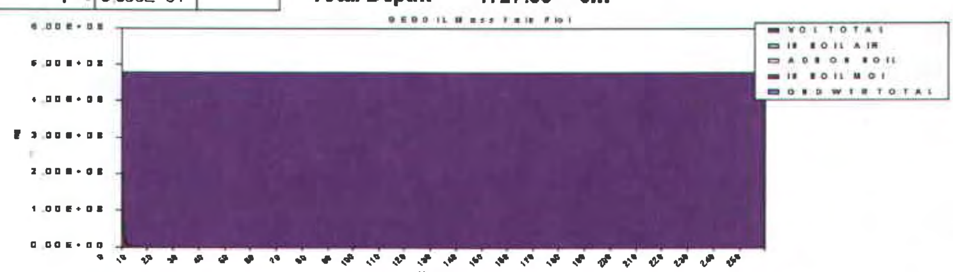

**Figure 9-4. 313-M SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the Final Action**

**SESOIL Output File:** C:\SEVIEW62\MP4A4.OUT

| SESOIL Process | Pollutant Mass (µg) | Percent of Total |
|---|---|---|
| Volatilized | 4.121E+07 | 100.02 |
| In Soil Air | 6.768E-03 | 0.00 |
| Sur. Runoff | 0.000E+00 | 0.00 |
| In Washld | 0.000E+00 | 0.00 |
| Ads On Soil | 1.524E-03 | 0.00 |
| Hydrol Soil | 0.000E+00 | 0.00 |
| Degrad Soil | 0.000E+00 | 0.00 |
| Pure Phase | 0.000E+00 | 0.00 |
| Complexed | 0.000E+00 | 0.00 |
| Immobile CEC | 0.000E+00 | 0.00 |
| Hydrol CEC | 0.000E+00 | 0.00 |
| In Soil Moi | 7.563E-03 | 0.00 |
| Hydrol Mois | 0.000E+00 | 0.00 |
| Degrad Mois | 0.000E+00 | 0.00 |
| Other Trans | 0.000E+00 | 0.00 |
| Other Sinks | 0.000E+00 | 0.00 |
| Gwr. Runoff | 1.079E-02 | 0.00 |
| Total Output | 4.121E+07 | 100.02 |
| Total Input | 4.121E+07 | |
| Input - Output | -7.992E+03 | |

**Maximum leachate concentration:** 1.000E-11 **mg/l**

**Climate File:** REDEVAP
C:\SEVIEW62\REDEVAP.CLM

**Chemical File:** Tetrachloroethylene (PCE)
C:\SEVIEW62\PCE_X.CHM

**Soil File:** Clayey Loam
C:\SEVIEW62\SILTY_CL.SOI

**Application File:** SEVIEW Default Application Parameters
C:\SEVIEW62\4A_AP.APL

**Starting Depth:** 590.70 **cm**
**Ending Depth:** 4727.00 **cm**
**Total Depth:** 4727.00 **cm**

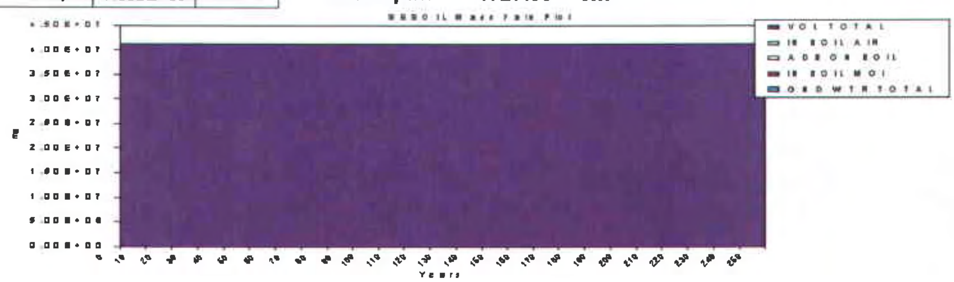

**Figure 9-5. MIPSL Manhole 4A SESOIL Modeling Results, Predicted PCE Mass and Phase Distribution for the Final Action**

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